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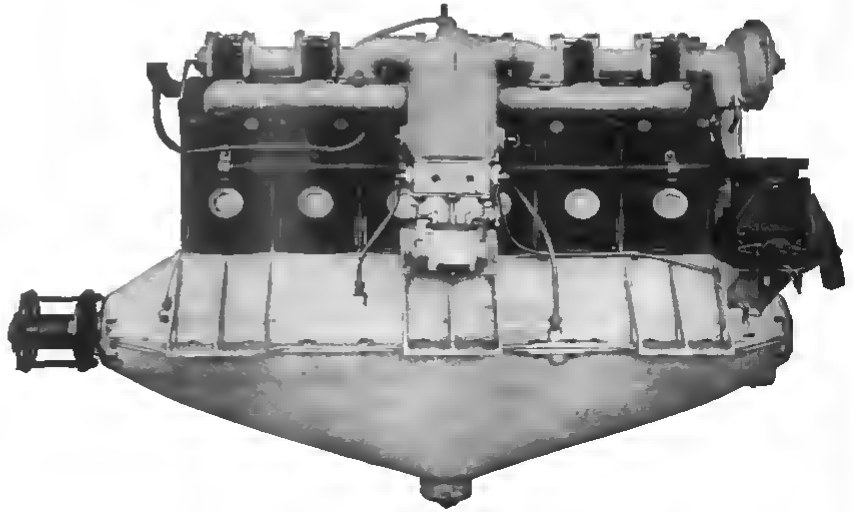

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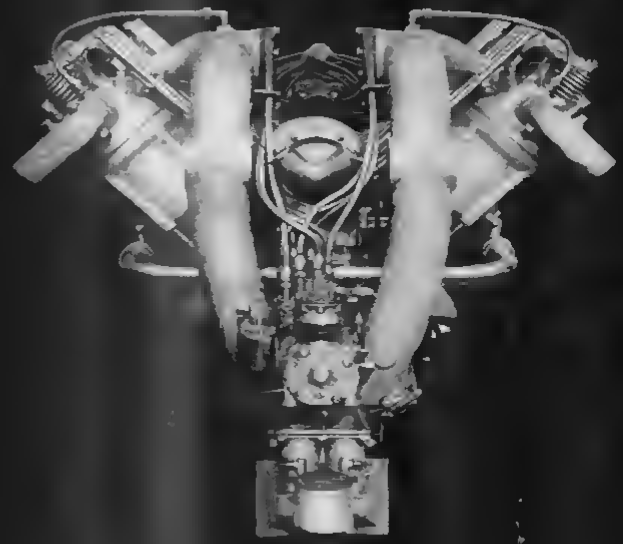

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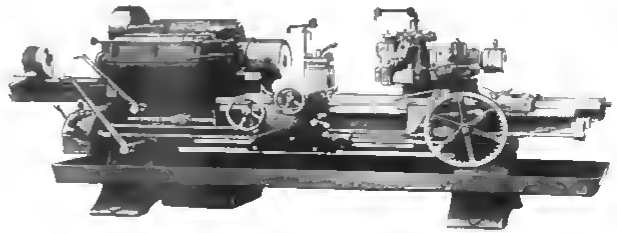

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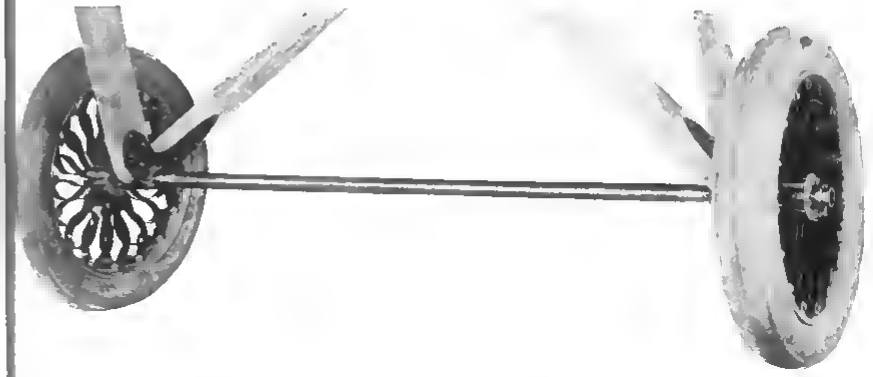

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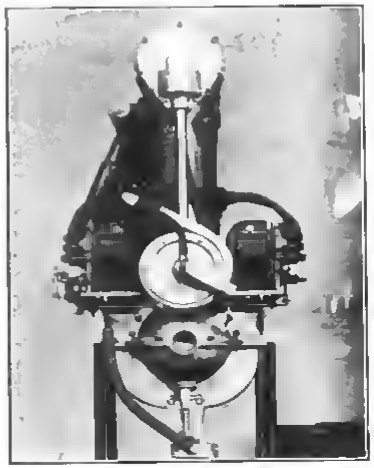

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VOL. III. NO. 3

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AVIATION AND AERONAUTICAL ENGINEERING

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Vol. III September 1, 1917 No. 3

PERIODS of expectancy are as a rule difficult to bear, the more so when uncertainty and silence play a vital role in the successful prosecution of a plan. The present status of the airplane building program adopted by the Army and Navy is so far as concerns the public, surrounded with military secrecy.

How far the construction of the several thousands of airplanes has proceeded and what results have been accomplished are and must needs be, kept from the press. Until results of military or naval importance occur, the public is expected to withhold judgment on the success or failure of the work that is being undertaken with the appropriations allotted this new service.

Rumors which have reached the public through the newspapers give the encouraging impression that a new appropriation for aircraft is likely to be asked from Congress. It is also hinted and this should cause widespread satisfaction, that the initial appropriation of $640,000,000 is to be largely exceeded in the second request.

If the United States is to secure the mastery of the air by next spring the requirements needed to accomplish this task will stagger the imagination of even those who thought that they had exhausted this faculty in the last year. But the knowledge that our military and naval authorities, the foreign experts, and the experienced business men who have been taken into the service are all agreed on a plan based on facts gained from the experience of our Allies, is reassuring as to the pressing need for expansion.

If those interested in our Air Service, which should include every citizen, will unflinchingly support those who are carrying out this great task, the country will find in a short time that the genius of America has once more forged the weapon which will achieve the triumph of democracy.

Scandal Hunters

One of the most fruitful sources of news is the suspicion of "graft." When all other sources of news fail, the easiest way to create a startling sensation is to gather an array of large sums and arouse a feeling of wrongdoing.

The widely printed news of the prices at which airplanes have been ordered by the Government, with the insinuation that they were excessive and extortionate, has served to bring out several statements from the authorities and constructors which have been a sufficient answer to the charges.

The public is likely to be startled when it learns of the great expense involved by the training of aviators and building of airplanes. It is generally estimated that the training of a military aviator costs between ten and twenty thousand dollars. Ground schools have to be maintained, great tracts of land must be acquired for flying fields, and a sufficient number of airplanes must be available so that one-half may be undergoing repair and overhauling while the other half is in service. Breakage is inevitable and engines rapidly wear out under the terrific strain of continually running at full power.

Motor trucks and motorcycles play an important part in the subsidiary equipment of a flying field, elaborate work shops with expert mechanics are just as much needed. All this expensive *materiel* is essential for the maintenance of efficient training stations.

The cost of the material that enters into airplane construction would be prohibitive in any other commercial product. Spruce and other woods used in airplane construction have risen to prices hitherto believed impossible. Virtually the same statement applies to linen. The metal fittings of airplanes require the finest material known to the metallurgist. The amount of manual labor expended on airplanes is so great that only those in the business realize its extent and cost.

It has been stated that the cost of applying the "dope" to the wings is greater than the cost of the linen. The only labor that can successfully be employed in airplane construction or engine work is that of the most expert wood workers and mechanics. To attract them from other fields has required great inducements. Rapid production of aircraft has called for continuous overtime charges.

Expanding organizations have been subject to wasteful experiments with half-trained, little experienced men, until real talent became available and produced the desired results. All these factors enter into the price charged to the Government, that a margin of safety should enter this price is but the manufacturer's legitimate desire to make fair profits.

Experimental work such as has been required by the Government is the most expensive of all kinds as it necessitates constant alterations of design which obviously defeat, to a large extent, the advantages derived from standardization.

The airplane manufacturers have been willing to meet the Government's prices on a fair basis and expert advice of the Aircraft Production Board can be relied upon to see that all parties will be treated fairly and that no undue advantage will be taken of the Government's position.

Controls and Control Surfaces

By W. J. Waterhouse

In the present article it is attempted to cover briefly the details of control surfaces from a structural point of view only, since much valuable information has previously been published on the aerodynamic properties of sections adapted to their use

In past years, little attention has been given to the design of elevators, rudders, stabilizers and ailerons, as to strength, probably because of the fact that but few of the early designers realized the magnitude of the stresses actually imposed

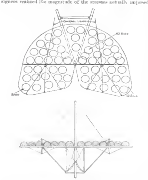


Fig 1

upon these members under adverse flight conditions However, with increase in size, speed, weight and horsepower of airplanes of today, designers have displayed more skill and judgment in the design of these ever important parts.

The United States Army specifications require that elevators and stabilizers be so designed as to show a factor of safety of 2½, when set at an angle of incidence of —20 deg and —6 deg respectively, for a speed of 100 m p h

The tail surfaces of each individual airplane are bound to have some particular characteristics of their own, for each of which the designer, if experienced, has some particular object in view, either efficiency, strength or simplicity of construction In this article, as a concrete example, the air loads on tail surfaces for the two-seater, unarmed tractor biplane of the reconnaissance type have been investigated, this type offering the following characteristics· Average weight, 2750 lb loaded; maximum speed, 87 m p h , minimum speed, 45 m.p h , horsepower, 150-160.

The average loading on the elevators and stabilizers for the conditions prescribed by the Government for machines of the above type and characteristics is equivalent to approximately 50 lb per square foot for the elevators and 22 lb per square foot for the stabilizers.

This is, however, based on the assumption that the elevators and stabilizers are working in a free and undisturbed flow of air, however, it is generally conceded that the flow of air past the stabilizer, when at high or low angles of incidence, is broken into eddies causing considerable interference with the air pressures on the elevators and rudder while being turned through their working range of positive and negative angles, but want of reliable wind channel data regarding this effect of interference forces us to treat the subject as though no interference existed

Tests

In tests conducted by the writer on a stabilizer and elevators the surfaces were double cambered and the structural elements were symmetrical so that the strength is the same whether the load acts vertically upward or downward

These surfaces were attached to a jig specially designed so as to support them in the same manner as when fixed to the body, the load was applied at the top face of the surface only, the general arrangement of the test is shown in Fig. 1 The loads consisted of small bags of sand weighing 17½ lb to a bag, and were arranged as shown The elevators sustained a distributed load of 455 lb or 27.5 lb per sq ft, while the stabilizers sustained a distributed load of 2250 lb or 55 lb per sq. ft

It might be of interest to state that at the time of failure all wood members were unaffected, the failure of the metal fittings being responsible for the collapse of the structure. I refer to this point in construction, because investigation of most control surfaces has led me to believe that the fittings were the weakest part of the whole design

Stabilizers or Tail Planes

Fig. 2 A shows the common trend of stabilizer design, i.e. a double cambered surface consisting of a rigid rectangular or I-section as the trailing edge a with the ribs c spaced at

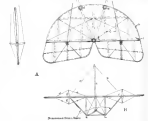


Fig. 2—A and B

equal intervals, the nose of which is mortised into a curved leading edge b which gives it the desired shape or outline.

Stabilizers are often made in two sections and are fitted to the sides of the body, about midway between the upper and lower longerons, but since the width of the body at the point where the stabilizer is usually attached is quite narrow, one finds that a lighter structure for the same strength can be designed by making the surface in one piece and placing it directly on top of the body This must however be securely fastened to the longerons at the points marked d, e, and f Fig 2-A and braced at the trailing edge with streamlined steel tubing, shown in Fig 2-B, at a point as near the elevator post as possible.

This brace can be carried directly below to some convenient point on the lower longeron, and if an elevator hinge be

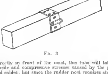


Fig 3

placed directly in front of the mast, this tube will take care of the tensile and compressive stresses caused by the pull on the control cables, but since the rudder post requires staywires a and b, Fig 2 B, leading from the top of the post x to a point intersecting that of the tube y on the trailing edge, we see that the structure is well braced

Stabilizers are very simple structures, and as one can ascertain with a fair degree of accuracy the loads imposed upon them there should be no difficulty in designing a very light and strong structure.

Hinges

The old and dangerous practice of using hinges made of screw eyes, whang leather, etc , to the failure of which many serious accidents of the past can be traced, has given way to greatly improved types, and most designs of today show hinges of light but sturdy construction For instance, the old practice of fastening hinges with wood screws as in Fig. 3, or of slotting out the beam as shown in Fig 4 along the neutral axis, and dropping bolts through, hoping they would pass through the holes in the hinge lip, has been superseded by more reliable designs, since it was necessary to drill the holes in the lip of the hinge, Fig. 4, on assembly The holes would not always be drilled so as to insure full strength of the hinge, in many cases these holes were found to have been drilled, as shown by the dotted half circles, and the hinge could be pulled free from the beam with but little effort

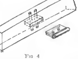


Fig 4

The use of wood screws should be discouraged in the construction of airplanes, especially at points heavily stressed,

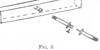


Fig. 5

because, as the wood ages, its structure changes, allowing the screws to eventually work free from their original seating. therefore, in no event should they be used in attaching control hinges.

There are at present several unique types of hinges displayed, but to describe them all would require too much space so I will confine my discussion to two of the most interesting The male and female eyebolt type, shown in Fig 5, is very light and very strong A broad flat shoulder is usually turned just below the eye to allow sufficient bearing surface, the shanks of the bolts are passed entirely through the neutral axis of the beam; a broad flat washer offers bearing surface for the nut, which is drawn tight, and cottered, making a very reliable hinge fitting.

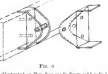


Fig 6

The type illustrated in Fig 6 is made from cold rolled steel, blanked out, and bent to the shape shown, this type is very sturdy in construction, but much heavier and more expensive than the eyebolt type.

Probably the only objection offered against these two types is the large space created between the trailing edge of the

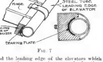


Fig 7

stabilizer and the leading edge of the elevators which allows leakage of air at that point. As a remedy for this trouble one designer has developed a type of hinge, shown in Fig. 7, that allows the two edges to butt together, but its use requires that the leading edge of the elevators, rudders, or ailerons be of steel tubing

Considering cost, weight, strength and production the eyebolt type has everything in its favor.

Elevators

In general, the design of elevators is quite similar. Fig. 8 illustrates common practice, the leading edge, a, consisting of either a steel tube or spruce of I-section, while the trailing

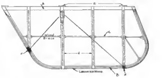


Fig 8

edge, b, is either laminated wood or ⅝ in. diameter thin gauge steel tubing, flattened to a cross section of ¼ x ¾ in. The

ribs, *d*, usually consist of a web and batten strips made of spruce, basswood, whitewood or some other light but strong wood, the completed structure being made rigid by cross bracing with light gauge aviator wire, or wood members as shown

There is some difference of opinion regarding the material used for the trailing edge of ailerons, elevators, rudders and wings In the earlier types of machines, it was common practice to lace the cloth to a wire stretched along the trailing edge and fastened at each rib On the later machines, material mentioned above is used

My own experience leads me to believe that the laminated wood is preferable, since it is lighter easier to attach and has the advantage of giving way at the point of stress in the event of striking obstructions

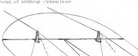


Fig. 9

As an illustration of the trailing edge of a surface comes in contact with a root or stake and punctures the cloth allowing the edge to pass around the object the wooden trailing edge fails only between the two nearest points of support, and leaves the surface fit for continued service at least until the pilot reaches his destination, and makes the necessary repairs.

This is not true, however of a surface with a trailing edge of steel tubing, for since the tubing is many times stronger than the wood members holding it in place, it will tear free from the surface, carrying portions of the cloth and structure with it

Where the elevators consist of a steel tube trailing edge, bent to shape and welded and riveted securely to each end of a steel tube which is used for the leading edge it is obvious that, should the trailing edge become engaged with protruding objects, the whole surface would be swept from the stabilizer If the hinge connections be of sufficient strength, it may even sweep the entire group of tail surfaces off the body, leaving the pilot helpless until new ones can be attached

The question of warping of wooden trailing edges can easily be overcome by treating the material with the proper kind of moisture proof varnishes, experiments have proven that wood properly proofed against moisture penetration will not warp.

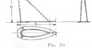


Fig. 10

As stated above, the design of elevators being quite similar to that of stabilizers one may expect similar surfaces to sustain similar loads under test, providing the manner and method of attaching hinges, braces and guy wires are similar.

It is quite obvious from Fig 9 that an elevator supported at three points, a, *b*, *c*, along its trailing edge can sustain a greater uniformly distributed load than one supported at but one point, *b* This same reasoning applies to the rudder, stabilizer and ailerons.

Some designers, in attempting to reduce the resistance of this structure, have advocated the use of a single guy wire; and on one occasion elevators were offered minus all brace wiring, the designer depending entirely on the control post to bear all stresses set up by the elevator The weakness of the single wire and wireless practice is at once revealed in submitting them to test

The practice of placing wireless ailerons, elevators and rudders on high speed machines of the scout type, has proven successful, but in this case the surfaces are of high aspect ratio, thereby reducing the lever arm length of the air load on

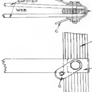


Fig. 11

the surface to a minimum These surfaces are also of a stream line form, and deep in cross section, allowing for internal bracing The masts are usually of minimum height *h* Fig 10 and streamlined with broad bases *b* are used in most cases the major axis of which is equal to the height

It is quite true that the fewer the turnbuckles and wires the less is the resistance offered yet one must expect to sacrifice efficiency for strength especially on units so important as the control surfaces

In attaching the guy wires leading from the control post to the trailing edge of all control surfaces, great effort should be made to get the strongest combination possible Fig 11 illustrates a reliable fitting

A steel strap, *a* is passed around the trailing edge *b* at the point where the rib intersects same, wire terminals *c*, being fitted above and below this point, so that a bolt passing entirely through the assembly binds it firmly to the trailing edge With this arrangement any stress imposed upon the fitting due to the pull of the guy wire is transmitted to the steel strap putting it under tension thus preventing the bolt from shearing through the wood, a case as would occur as shown in Fig 12, where a bolt is passed through the rib end with no provision to prevent it shearing or splitting the wood in the direction of the force applied

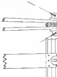


Fig. 12

Proper location of the hinges along the leading edge means a light strong structure and since we can estimate the load per inch run along this edge, we can calculate for a condition of hinge location that will give the best results

The present practice of leading a brace wire from a point where the rib intersects the trailing edge, as shown in Fig 13 to the control mast, *a*, *b*, and making no provision to relieve the rib of the bending stress caused by the angularity of the brace wire, *a* is not to be recommended, this difficulty can easily be overcome by placing a brace between a and *b* and parallel to the guy wires This member would then be put in direct compression and the ribs proper would be relieved

Control Surface Mast

Fig 14 illustrates the general type of control mast now in use. Parts *a* and *b* are stamped from sheet steel, formed to give the proper shape, and brazed In mounting the mast in the desired position on the elevator, care must be taken to anchor the base, *b* in such a manner that the bolts be not over stressed

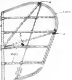


Fig. 13

Knowing the pull on the control lead, the length of the mast, the distance between bolts, and the load on the elevator, calculation will be easy for best results, since the load on the elevator is transmitted through guy wires to the top of the mast and at that point balanced by the pull on the control lead so that the stress in the mast is mostly compression

When the angle between the control lead and the mast is

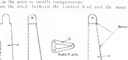


Fig. 14

some provision should be made for taking out of the thrust, in the horizontal plane, by wires arranged as shown at *d*, *c*, *h*, Fig 2B

During the sand loading test referred to above the writer noted that the elevator masts designed as shown in Fig 15 failed long before the structure showed any signs of collapse due to the fact that the point of attachment for the control lead, *a*, was so far above the point of guy wire attachment *b* that the part failed by bending across the portion just below the point, *b*, owing to the horizontal component of the force, exerted through the control lead, acting through the distance, *c* It was necessary to replace the mast with one similar in design to that shown in Fig. 16 before the test could be completed

Fig. 15

It will be seen from Fig 16 that the control lead and elevator brace wires pull from the same point, thereby overcoming the cantilever effect of the pull of the control lead at the point, a, Fig. 15.

Control Members

The writer recently conducted tests to determine what force, in man pounds, the average pilot could exert directly upon the control levers.

The results of the investigation showed that a force of 200 lb could be exerted in pushing or pulling upon the control bridge or yoke, 150 lb twist or torsion upon the wheel and 200 lb. upon the foot bar.

The average control arrangement allows a ratio of 2 to 1 between the control levers and the tail surfaces, i e, a force of twice that applied on the levers is imposed upon the tail surfaces.

These figures represent the average, since several men of different weight and strength were tried in the experiment, and conditions were ideal, therefore one can hardly expect that the pilot in actual flight would be capable of exerting such pressures, although a student pilot, in a state of fright, may exert even greater forces

In nearly every machine where the Dep control is used it is quite common practice to pivot the control yoke at the seat rails as shown in Fig 17, at a point so that the distance from the axis of the yoke to the axis of the wheel is from $1\frac{1}{2}$ to 2 times the distance from the yoke axis to the cable connections This practice varies, however, with different types of machines.

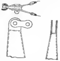


Fig. 16

While the Dep control is very reliable, it is bulky and necessitates a wide body to prevent cramping the pilot The stick control has proven its worth abroad It is much lighter and less complicated and requires less width of body, for the same radius of operation given by the Dep; it also has the advantage of being mounted to the floor thereby relieving the seat rails of unsuitable stress

For large machines the Dep control is preferable and can be installed without fear of any cramping, as the body is necessarily of sufficient width to permit the mounting of the yoke so as to allow for a roomy cockpit

It is quite evident from the tests, that every precaution should be taken to design the seat rails, yoke and seat connections, so as to give a good margin of safety

Considering the stresses imposed upon the seat rails, due to

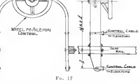


Fig. 17

the effect of centrifugal force on the body of the pilot in coming out of a loop or steep dive, we find that the stresses may be increased to as much as five or six times that of the normal load

That these stresses are worthy of serious consideration is evidenced by the fact that only recently a pilot in coming out of a loop was forced entirely through the seat, but regained control in time to land the machine safely The mounting of seats, seat rails, control levers, and foot bars, deserve every consideration, for the dangers of a weak control system are unlimited

In mounting rudder bars, some provision should be made for adjusting same, as the lengths of pilots' legs vary with their stature. Quite often flights of several hours' duration are required, and nothing is more tiresome than being compelled to hold the legs for long periods in an overstretched or a cramped position, therefore, no effort should be spared in making the pilot comfortable

Comparative Tests of Wing Sections

By Alexander Klemin and G. M. Denkinger

In AVIATION AND AERONAUTICAL ENGINEERING for April 15, 1917, were given the results of tests on six U. S. A. wing sections. In view of the variations in efficiency with size of model and wind velocity, no true comparison can be made between such sections and others in common use unless the tests are all made on the same size of model and at the same wind speed. To make such comparison possible tests have recently been carried out at the Massachusetts Institute of Technology on the R.A.F. 3, R.A.F. 6 and Eiffel 32 sections.

These sections have been described in numerous publications since their first issue, and the exact dimensions are also given in the Oct. 1, 1916, issue of AVIATION AND AERONAUTICAL ENGINEERING. In Table 1 are tabulated values of K_y, K_x, L/D, and positions of the C.P. In Fig. 1 are given the curves for K_y and K_x for the various sections, and Fig. 2 those for L/D.

It will be noted that the values of K_y check very closely with the European results in every case, but that the figures for L/D are, in the case of the R.A.F. wing, better than the original ones, while, on the other hand, the Eiffel 32 sections tested at the M.I.T. gave a maximum value markedly inferior to that obtained by M. Eiffel for a similar wing.

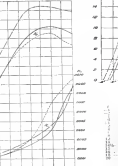


FIG. 1

The M.I.T. tests were all run at a speed of 30 m.p.h., and the models used were 18 x 3 in., whereas the tests made at the National Physical Laboratory on the R.A.F. wings were run at a speed of only 30 ft. per sec., and the models were 15 x 2½ in.

Eiffel's model was 35.4 x 5.9 in., and three tests were made, at speeds of 22.4, 44.8, and 67.2 m.p.h.

Past experiments, as well as those now under consideration, indicate that the value of K_y in a wing is virtually independent of the size of the wing and the wind speed, but that K_x depends on VL, and decreases as VL increases. The magnitude of this effect varies in different wings, and is very large in the Eiffel 32. The value usually quoted are those for the highest speed, which showed a maximum of 18.4, but the maxima for 45 and 22 m.p.h. were only 16.6 and 13.4, respectively, the last figure being inferior to that obtained at M.I.T.

It is evident from this that the superiority of the Eiffel 32 section is more apparent than real, and that, for tests under similar low-speed conditions, there are several sections which are superior to it in every way, aerodynamically speaking, except as regards the C.P. travel.

It is impossible to say with certainty what the relation would be at the speeds used in flight, since the effect of speed on the drift coefficient of the Eiffel 32 is so very great that it is improbable that any of the other sections would increase their maximum values of L/D in so high a degree for a change of velocity from 30 to 70 or more miles per hour. On the other hand, the Eiffel 32 has the disadvantage of a low lift coefficient.

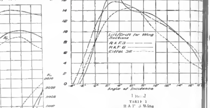


FIG. 2

TABLE 1

i	K_y	K_x	L/D	C.P.
R.A.F. 3 Wing				
−4	.000082	.000175		[illegible]
−2	.000601	.000128	4.8	[illegible]
−1	.000879	.000109	8.0	[illegible]
0	.001110	.000101	11.0	[illegible]
+1	.001314	.000100	13.2	[illegible]
2	.001554	.000109	14.3	[illegible]
4	.001862	.000124	15.3	[illegible]
6	.002288	.000150	14.9	[illegible]
8	.002777	.000207	13.4	[illegible]
12	.003438	.000318	10.9	[illegible]
14	.003481	.000378	9.2	[illegible]
14½	.003481	.000405	8.6	[illegible]
15	.003481	.000425	8.2	[illegible]
16	.003472	.000468	7.4	[illegible]
18	.003406	.000588	5.7	[illegible]
20	.003276	.000908	3.7	[illegible]
				(N. P. L.)
R.A.F. 6				
−4	−.000408	.000133	−3.44	[illegible]
−2	.000072	.000090	0.92	[illegible]
−1	.000285	.000081	2.40	[illegible]
0	.000571	.000077	7.20	[illegible]
1	.000821	.000068	12.10	[illegible]
2	.001072	.000068	15.78	[illegible]
4	.001477	.000090	16.58	[illegible]
6	.001878	.000128	14.14	[illegible]
8	.002268	.000167	13.60	[illegible]
10	.002534	.000207	12.32	[illegible]
12	.002682	.000255	11.18	[illegible]
14	.002818	.000321	8.28	[illegible]
16	.003048	.000434	8.02	[illegible]
18	.002987	.000698	4.48	[illegible]
20	.002871	.000887	3.20	[illegible]
				(M. I. T.)
Eiffel 32				
−4	−.000242	.0001115		[illegible]
−2	+.000152	.0000735	2.2	[illegible]
−1	.000378	.0000765	4.8	[illegible]
0	.000581	.0000747	7.3	[illegible]
1	.000788	.0000785	10.2	[illegible]
2	.001011	.0000842	12.0	[illegible]
4	.001467	.0001062	13.9	[illegible]
6	.001894	.0001305	14.5	[illegible]
8	.002280	.0001741	12.9	[illegible]
12	.002732	.000324	8.4	[illegible]
16	.002908	.000710	4.1	[illegible]
18	.002761	.000848	3.3	[illegible]
20	.002642	.000956	2.8	[illegible]

Aviation Engines with Particular Reference to Benz and Mercedes Types

By E. H. Sherbondy

It was my good fortune to secure from the Baron Charles Huard two engines from airplanes which were shot down in France during the last year. These engines I have had dismantled, and am now able to give full particulars of the 170 h.p. Benz and one of the Mercedes type, which is a twin-six, and which was probably built by Renault.

The Mercedes Engine

The 150 h.p., six-cylinder Mercedes engine, which is 5½-in. bore and 6$\frac{5}{16}$-in. stroke, won all the important places in the Kaiser prize contest with the exception of the first prize, which went to the Benz. The Mercedes company started with smaller-sized cylinders, namely, 3$\frac{15}{16}$-in. bore and 5½-in. stroke, six cylinders. The principal features of the design are forged steel cylinders, with forged steel elbows for gas passages, pressed steel water jackets, which when welded together form the cylinder assembly, the use of inclined overhead valves operated by means of an overhead cam shaft through rocker arms which multiply with the motion of the cam. By the use of steel cylinders, not only is the weight greatly reduced, but certain freedom from distortion through unequal sections is secured, and leaks and cracks are entirely avoided. The construction is necessarily very expensive. In the details of this construction there are a number of important things, such as finished gas passages, water-cooled valve guides and a very small mass of metal, which is water-cooled surrounding the spark plug. Of course, it is necessary to use very high compression in aviation engines in order to secure high power and economy, and owing to the fact that aviation engines are worked at nearly their maximum, the heat flow through the cylinder, piston, and valves is many times higher than that encountered in automobile engines. It has been found necessary to develop special types of pistons to carry the heat from the center of the head in order to prevent preignition.

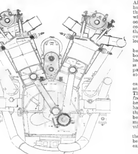


FIG. 1. TWIN-SIX MERCEDES ENGINE

In the Mercedes engine the pistons have a drop forged steel head, which includes the piston pin boss, and this head is screwed into a cast-iron skirt which has been machined inside to secure uniform wall thickness.

The carburetor used on this 150 h.p. Mercedes is precisely of the same type used on the twin-six engine, which shall hereafter be described. It has two venturi throats, in the center of which is placed the gasoline spray nozzle of conventional type fixed size orifices, immediately above which are placed two panel type throttles with side outlets. An idling or primary nozzle is arranged to discharge above the top of the venturi throat. The carburetor body is of cast aluminum and is water jacketed. It is bolted directly to the air passage, passing through the top and bottom half of the crank case, which passes down through the oil reservoir. The air before reaching the carburetor proper has, to some extent, cooled the oil in the crank chamber, and has itself been heated to assist in the vaporization. The inlet pipes themselves are copper. All the passages between the venturi throat and the inlet valve have been carefully finished and polished. The only abnormal thing in the design of this engine is the short connecting rod, which is considerably less than twice the stroke and would be considered very bad practice in motor-car engines. A short connecting rod, however, possesses two very real virtues, in that it cuts down height of the engine, and the piston passes over the bottom dead center much more slowly than with a long rod.

Other features of the design are a very stiff crank case, both halves of which are bolted together by means of long through bolts; the crank shaft main bearings are seated in the lower half of the case, instead of in the usual caps, and no provision is made for taking up the main bearings. The Mercedes company uses a plunger type of pump having mechanically operated piston valves, and it is driven by means of worm gearing.

The overhead cam shaft construction is extremely light. The cam shaft is mounted in a nearly cylindrical cast bronze case, and is driven by means of bevel gears from the crank shaft. The vertical bevel gear shaft through which the drive is taken from the crank shaft to the cam shaft operates at one and one-half times the crank shaft speeds, and the reduction to the half-time cam shaft is secured through a pair of bevels. On this vertical shaft there are mounted the water pump and a bevel gear for driving two magnetos. The water pump mounted on this shaft tends to steady the drive and avoid vibration in the gearing.

Fig. 1 illustrates the latest type of aviation engine built by the Mercedes company concerning which any information has been available. This engine is an evolution from a number of earlier types, the first of which was put into operation in 1912.

The largest Mercedes engine has recently had its horsepower increased to 176 h.p. at 1450 r.p.m. This general design of engine has been the foundation for a great many other aviation engine designs, some of which have proved very successful, but none of which, in the writer's estimation, is equal to the original.

The Renault Engine

The next engine to be considered is the V-type, twin-six Renault of 4$\frac{5}{16}$-in. bore and 6$\frac{5}{16}$-in. stroke. The first important peculiarity of this design is the small angle between the cylinders, which is only 47½ deg., enabling the body to be considerably narrowed in width, thus reducing the head resistance. The cylinders are almost a duplicate of the Mercedes design of steel cylinder, with the exception that the elbows in which the valves are inserted are not so carefully designed, and the water jacket is carried around only one side of the exhaust valve stem, whereas in the Mercedes the water jacket completely surrounds the exhaust valve stem. It appears to be absolutely essential to cool the exhaust valve as much as possible, since pre-ignition is likely to occur always from one of three sources—the spark plug, which is the arch offender, the exhaust valve or the center of the piston head. There are two valves per cylinder, 2⅝ in. in diameter.

It is important in aviation engines to have considerable width of seat, as it greatly assists in carrying the heat off the exhaust valve. The end of the valve stem is threaded to carry the spring cap and lock nut. Each of the cylinder bands, to-

gether with the head, are machined from a forged bar, after which the intake and exhaust elbows are welded on, and finally the pair of cylinders are encased in a jacket, which is welded up from three pieces of steel approximately $^1/_{16}$-in. thick. The cylinder walls themselves are $^1/_{16}$-in. thick. A standard two-bolt flange is used for all intake and exhaust port connections.

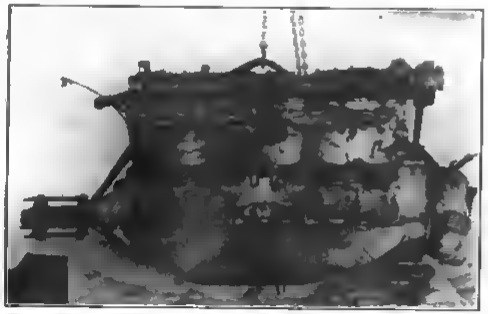


FIG. 2. TWIN-SIX RENAULT ENGINE, FROM WRECKED AIRPLANE

and has been called out of steel. The flanges are screwed on to the cylinders and welded and brazed on to the intake and exhaust pipes.

The pistons are of cast iron, and are the only very heavily designed pieces in the engine. It certainly seems that these could have been considerably lightened. The piston carries three concentric rings, which are pinned at the ring gap and have a deep annular rib between the bosses. The pistons are also unusually short. There are eighteen $^{11}/_{32}$-in. holes drilled into the skirt, but these holes must have been drilled for oiling purposes, as they do not materially reduce the weight of the pistons.

The connecting rods are of the articulated type, and the short rod is alternately arranged from right to left cylinder from the front of the engine to the back.

The connecting rods are made of B.N.D steel I-beam section, with a flange and web of approximately $^1/_{16}$-in. thickness. In the short connecting rod both ends of the rod are alike. The length of the rod is $11^{15}/_{32}$ in. The rod cap is secured by means of three bolts.

The crank shaft is carried in four babbitt-lined bronze shells, which in turn are secured to ribbed steel bearing caps.

The bearing caps are locked in the top of case by means of long U-bolts, such as are sometimes used on automobile spring saddles. The shaft is drilled out for lightness, but oil is carried from the main bearings by means of

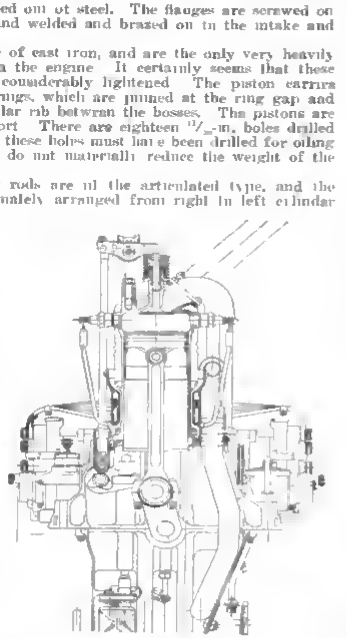


FIG. 3. END VIEW OF SIX-CYLINDER BENZ ENGINE

thrower rings and separate small steel pipes to the connecting rod big ends. The front end of the crank shaft is splined to mount the starting gear and accessory drive. The bottom half of the crank case is illustrated. It simply serves as an oil pan and has a screen separating it into two partitions. The water pump is mounted on the front of the engine from the bottom half of the crank chamber. The water is piped to either side of the engine, copper pipes and rubber connections are interposed to prevent cracking joints due to vibration.

The carburetor differs from the Mercedes only in that it has a single float chamber instead of two float chambers. There are two carburetors mounted on either side of the engine, bolted to either side of the crank case by means of long studs. The intake pipes, which are fastened by means of unions to the carburetor, are made of copper tubing.

The carburetor has a pair of primary nozzles and a pair of secondary nozzles, and an auxiliary air valve, which consists of an annular ring mounted on concentric with a venturi throat. It would seem that this auxiliary air valve was a dangerous construction to go up in the air with, as it is very likely to stick.

The oiling system is extremely simple. Oil is to be carried through cast ducts in the front and rear compartments of the crank chamber to the main bearings. It is also carried from these ducts through two copper tubes up to the overhead cam case and passes through the cam shaft case from the propeller to the starting end of the engine, and returns down through the distributing gearing case to the oil sump.

The valve gear is of very elaborate, expensive design. The main scheme of the construction is to use a light steel tube carried on the studs from the cylinder head, which is slotted to take bronze cages from both the cam shaft bearings to rocker arm mounting. The rocker arms are arranged to multiply the cam motion so that the valve opens $^7/_{16}$ in. The cam shafts are driven through straight bevel gears, and the inclined shafts which drive the cam shafts operate at three times cam shaft speed. The high speed of these shafts and the resulting lowering in torque on them allows their weight to be considerably decreased.

At first sight it would seem that the construction is a very complicated and expensive one, but this arrangement is much cheaper and very much lighter than where a train of spur gears is used for driving magnetos, cam shafts, etc. The Peugeot company introduced the use of spur gears for overhead cam shaft driving, and this construction has been copied by Sunbeam, Wisconsin and Packard. In a twin six or an eighteen cylinder motor, the number of gears necessary with this gearing arrangement forms a maze of complication. There are four magnetos mounted on the same axis, each pair being driven through a spur gear, which in turn meshes with a spur gear which is slightly mounted on a spiral magneto drive shaft. The magneto drive shaft terminates at its forward end in the sleeve of a bevel gear, and is helically splined into the bevel gear so that when longitudinally displaced the shaft is also angularly displaced. This construction is quite possibly but is the best one the writer has seen, since it avoids a lot of connections to magneto breaker boxes, and also insures a spark of the same intensity, regardless of whether the ignition is advanced or retarded.

At the front end of the crank shaft there is mounted a six-cylinder, air starting motor, which engages the crank shaft by means of an overrunning clutch. This air starting motor has a single inlet discharge valve for six cylinders of the rotating disc type. There is also built integral with this starter a hand-starting gear and the starting magneto drive.

The Benz Engine

In the Kaiser prize contest for aviation engines, a four-cylinder Benz of $5^1/_8 \times 7^1/_8$ in. won first prize, developing 160 b.h.p. at 1290 r.p.m. The fuel consumption was 462 lb. per horsepower hour. Total weight of the engine was 337 lb. The oil consumption was .044 lb. per horsepower hour. This engine was afterward expanded into a six-cylinder design, and three different sizes were built.

The three sizes were rated at 85, 100 and 150 h.p., respectively. We shall particularly consider the largest, which is a six cylinders, $5^1/_8 \times 7^1/_8$ in., and which weighs 510 lb. complete. The fuel consumption is .50 lb. per horsepower hour.

The Benz cylinder is simple, straightforward and a very reliable construction, and not particularly difficult to manu-

facture. The cylinder is cast of iron without a water jacket, but including 45 deg. angle elbows to the valve ports. The cylinders are machined wherever possible, and at other points have been hand filed and scraped, after which a jacket which is pressed in two halves is gas welded by means of short pipes welded on to the jacket. The bottom and top of the cylinders become water galleries, and by this means separate water pipes, with their attendant weight and complications, are eliminated. Rubber rings held in aluminum clamps serve to connect the cylinders together. The whole construction turns out very neat and light. The cylinder walls are $^5/_{16}$-in. thick, and the combustion chamber is of cylindrical pan-cake form.

In order to insert the valves into the cylinder, the valve stem is made with two diameters, and the valve has to be corked to insert it in the guide, which has a bronze bushing at its upper end to compensate for the smaller valve stem diameter. The valves are operated through a push rod and rocker arm construction which is exceedingly light. Rocker

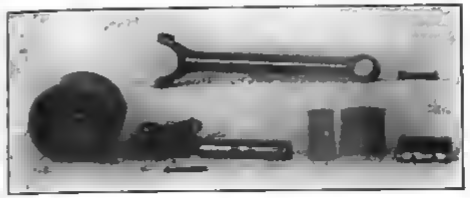


FIG. 4. PISTON, CONNECTING ROD, PISTON PIN, ETC., OF 150 H.P. BENZ ENGINE

arm supports are steel studs with enlarged heads to take a double row ball bearings. A roller is mounted at one end of the rocker arm to impinge on the end of the valve stem, and the rocker arm has an adjustable globe stud at the other end. The push rods are light steel tubes, and have a hardened steel cup at their upper end to engage the rocker arm globe stud, and a hardened steel globe at their lower end to socket in the roller plunger.

The cam shaft is hollow, and there is a spiral gear made integrally with the shaft in about the center of its length, for driving the oil pump gear. There is, in addition to the intake and exhaust cams, a set of half compression cams. The shaft is noted longitudinally in its bearings by means of an eccentric by which these cams into action. At the fore end of the shaft is a driving gear flange which is very small in diameter and very thin.

The seven bearing crank shaft is finished all over in a beautiful manner, and the shaft out of the particular engine we have shows no signs of wear whatever. Through both the crank pin and main bearings there is drilled a hole, and the crank cheeks are plugged with solder. The crank cheeks are also built to convey the lubricant to the crank pins. At the fore end of the crank cheek there is pressed on a spur driving gear. There is screwed on to the front end of the shaft a piece which forms a bevel water pump driving gear and the starting dog. At the rear end of the shaft, very close to the propeller hub mounting, there is a double thrust bearing to take the propeller thrust.

Long shouldered studs are screwed into the lower portion of the case and pass clean through the bottom half of the case. The case is very stiff and well ribbed. The three center bearing diaphragms have double walls. The center one serves as a duct through which water pipe passes, and those on either side of the center, from the carburetor intake air passages, are enlarged in sections at one side to take the carburetor barrel throttle.

The pistons are of cast iron, and carry three concentric rings, $^1/_4$ in. wide, on their upper end, which are pinned at the joint. The top of the piston forms the frustum of a cone. The lower portion of the skirt is machined inside. Riveted to the piston head is a conical diaphragm, which contacts with the piston pin when in place and serves to carry the heat off the center of the piston.

In Fig. 4 are shown the parts of the piston and connecting rod assembly, and it will be observed that the rods are tubular and have a four-bolt construction on the big end, babbitt-lined bronze bushings, and are locked in place by means of connecting rod bolts, which pass through the sides of the bushings. The piston pin has a hole bored straight through, and is retained in the piston by means of a threaded taper pin which screws into the piston pin boss. The end of the piston pin is slotted so that the taper pin expands the end of the piston pin and forms a very certain retention.

The oil pump assembly comprises a pair of plunger pumps which draw oil from a separate outside pump, and constructed integrally with it is a gear pump, which delivers the oil under about sixty pounds pressure through a set of copper pipes in the base to the main bearings. The plunger oil pump shows great refinement of detail. A worm wheel and two eccentrics are machined up out of one piece and serve to operate the plungers. This Benz engine design is the most attractive from the manufacturing standpoint of any the writer has seen, but the progress in aviation engines has been so rapid that the design of this engine is already obsolete.

The mean effective pressures secured in this engine were probably never over 108 pounds, and there are certain of the European engines that are now giving 30 per cent higher mean effective than this. In fact, the Benz company has produced a later design with four valves per cylinder of the same size, namely, $5^1/_8$ in. x $7^1/_8$ in., which gives 225 h.p. at 1500 r.p.m. No details of this construction are available so far as is known.

The Austro-Daimler Engine

One of the first very successful aerial engines which was developed in Europe is the Austro-Daimler, which was built after the designs of Porsche. The first had four cylinders, $4^3/_4 \times 5^1/_2$ in., bore and stroke, with cast-iron cylinders, overhead valves operated by means of a single rocker arm, controlled by two cams, and the valves are closed by a single leaf spring, which oscillates with the rocker arm. The cylinders are cast singly, and have either copper or steel jackets applied to them. The four-cylinder design was afterward expanded into the six-cylinder design, and still later a six-cylinder engine, $5^1/_2 \times 6^7/_8$ in., was developed. This engine used an offset

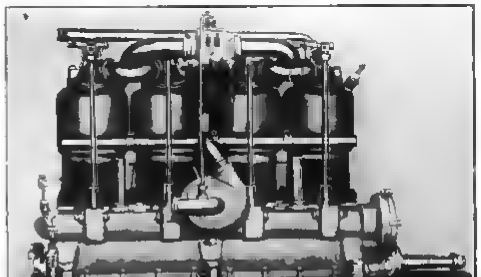


FIG. 5. FOUR-CYLINDER AUSTRO-DAIMLER ENGINE

crank shaft. The Benz also uses an offset camshaft which improves the valve operation and changes the valve lift diagram. In my estimation, the intake pipe and carburetor arrangement on the Austro-Daimler are the best of any of the aviation engines.

The lubrication also is different from any other aviation engine, since individual high pressure metering pumps are used to deliver fresh oil only to the bearings and cylinders, as was the custom in automobile practice some ten years ago.

Effect of Offset Cylinders Relative to Crank Shaft

Two of the engines described, the Benz and the Austro-Daimler, use the offset crank shaft construction, and this has for a long time been quite common in German and Belgian construction. Offsetting the crank has two effects, one to cut

down the guide pressure of the piston and cylinder, and the other (which is purely a secondary effect) of lengthening the stroke of the piston as the offset is increased with any given crank pin circle.

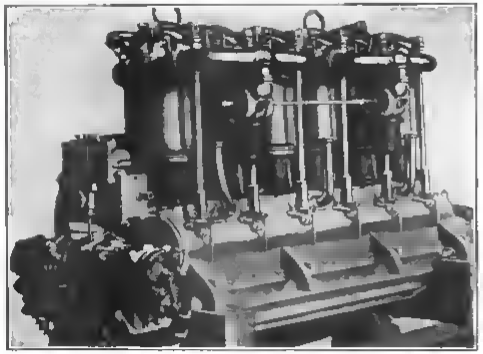


Fig 6—Six-Cylinder Austro-Daimler Engine

Sizes of Engines Required

It begins to be more and more apparent that engines of less than 200 h.p. have only a limited field

In connection with the ideas that seem to be cropping up in some quarters relative to standardization of aeronautic engines, I wish to utter a warning

What we need immediately in America is a large number of training planes; but we also will have to have battle planes driven by engines that are not equal to, but superior to, those possessed by the enemy. The real danger, in my estimation, is that the evolution of our engineering will not be fast enough. We have not as yet enough clever minds engaged in these channels, and we have not had stimulus for this sort of work. We have always had, continually in the past, that specter, cost, staring us in the face. A lieutenant in the British Royal Flying Corps said recently that there was no question of price at all if an engine would "deliver the goods." A very great deal has been done toward securing high horsepower weight efficiency by means of lightening the various parts of the structure, and I feel very certain that in a great many particulars this line of thought has reached its limit.

The really important thing about aeronautic engines from now on is going to be the number of cubic feet of mixture per minute that they can handle, and in connection with four-stroke cycle motors this points out the necessity of using relatively high speeds. The mean effective pressures arrived at in the Sunbeam engines are within 15 per cent of the theoretical maximums that are possible, and while there may be some improvement secured in the future in the matter of horsepower weight efficiency by means of further refinement in the mechanical construction, I believe that it is now necessary to ring in some changes upon the cycle of operation. This should be a splendid opportunity to try out super-compression and super-charging schemes of one sort or another, and possibly for those who have energy to try it, the two-stroke engine, with its maze of new problems, stands as an opportunity

Blowers for Ballonets

A few months ago the Navy Department awarded contracts for the construction of several "Blimps," a type of non-rigid dirigible, similar in general design to those now being used

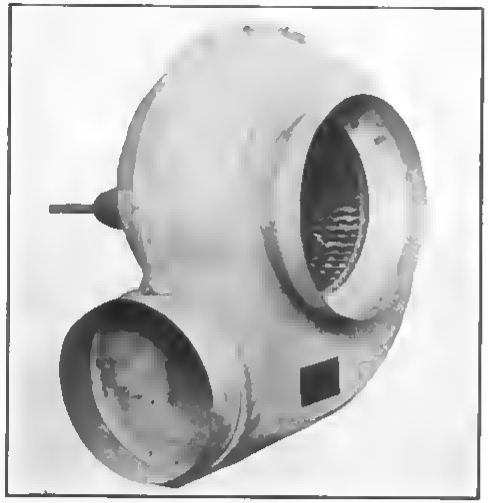


Fig 1

on successfully by the Allies for scouting and coast defense purposes.

The trimming of a dirigible depends either upon the manipulation of horizontal rudders, the releasing of water from small containers, or by the shifting of air between ballonets or small balloons located near the bow and stern, inside of the gas envelope.

The air used in the ballonets is handled by a blower system consisting of a small gasoline engine of the motor cycle type, developing approximately 2 h.p., and a Multivane blower. The blower is driven by a V belt or clutch, as conditions determine

The B. F. Sturtevant Company of Hyde Park, Boston, Mass., has developed a special dirigible blower (Fig 1) for this purpose. The excellent performance of this blower is well illustrated by the test (Fig 2) witnessed and signed by a Government Inspector. A large number of these blowers

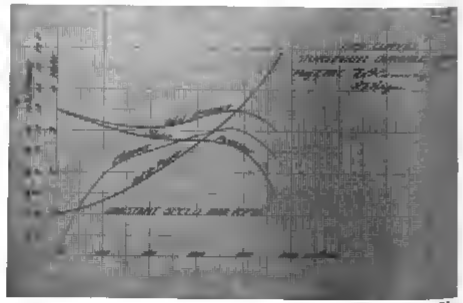


Fig. 2

have been delivered by the Sturtevant Company, and will be installed in all of the Government "Blimps" now on order

The housing consists of two aluminum castings, which are remarkable from a construction standpoint, being only ⅛ in. thick. The hanger, to which the housing is attached, is also made of aluminum, and contains two ball-bearings, which support the driving shaft. The fan is of the overhung type.

The Economical Arrangement of Dry Kilns*

By Thomas D. Perry

of the Grand Rapids Veneer Works

The selection of a dry kiln for any plant involves a number of considerations and usually results in a compromise between the ideal from a kiln standpoint and the plant owner's desires in order to simplify the compromise and promote better efficiency the following suggestions are offered to aircraft manufacturers relative the installation of dry kilns

The day of large single kiln units, from 50 feet to 100 feet square, is gone, its place being taken by the battery of relatively small unit kilns. Modern lumber manufacturing in airplanes as well as other lines tends toward diversified kinds and thicknesses of lumber. Efficiency demands that each variety be segregated and given different treatment

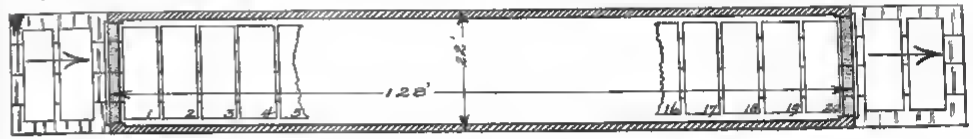


Fig 1

The type of long progressive kiln approximately 20 feet wide by 120 feet long, holding 20 kiln cars or 75,000 feet (BM) of lumber as shown in Fig 1 is rarely good practice because few manufacturing operations have sufficiently uniform demands. With exceptionally uniform output this type may serve fairly well. The satisfactory use of a progressive kiln of this type requires

I. Uniformity of lumber put in and taken out.

II. A minimum disturbance to kiln operating conditions due to the daily removal, forwarding, and insertion of one or more kiln cars of lumber

III. An exceedingly careful regulation of heat to have it mild at the loading or entering end and hot at the unloading end. Correspondingly the humidity must be high at loading and low at unloading. A kiln less than 80 feet long will not permit the necessary variations from end to end

The second point usually causes a loss of about ten per cent of the operating period, including the time necessary to cool

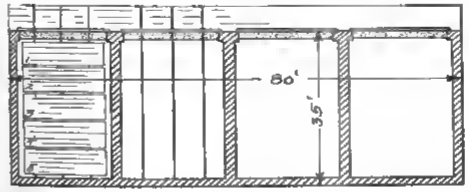


Fig. 2

the kiln so that workmen can enter to forward cars and until the interrupted operating conditions of heat and humidity are restored. The physical danger and discomfort to workmen in entering so hot a kiln on a very cold or hot day are apparent

The third point, the maintenance of variable conditions in different parts of the kiln, is a source of continual difficulty. The careless or unintentional overheating of the kiln in the initial stages of drying will almost always cause serious checking or case-hardening of the lumber. Efficiency can only be attained by treating each kind of thickness of lumber according to its special needs. Combining several kinds of thickness in one kiln is never desirable.

The modern and efficient type of kiln is the battery of unit box or single charge kilns as shown in Fig 2. The initial cost may be a little higher but the economy of operation is much greater. In this type of kiln the lumber is segregated into kinds, thicknesses and degrees of wetness. The total holding capacity of kilns shown in Figs. 1 and 2 is the same; i.e., 20 kiln cars or 75,000 feet of one inch lumber.

In the box kiln one unit is filled at a time, then closed, and the entire contents subjected to an initial high humidity and low temperature and these gradually modified by increasing the heat and reducing the humidity as shown on the graphic chart. At any given time the entire interior of the kiln is subject to the same condition of temperature and humidity.

Kilns of the progressive or box type may be used for lumber piled endwise (parallel to the rails) or crosswise (transversely to the rails). For work requiring such various sizes of stock as aircraft the endwise piling is preferable, because it lends

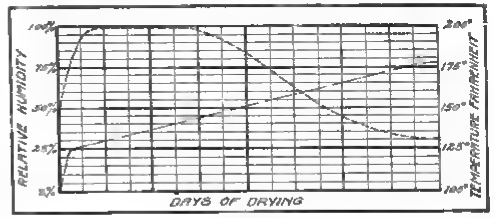


Fig 3

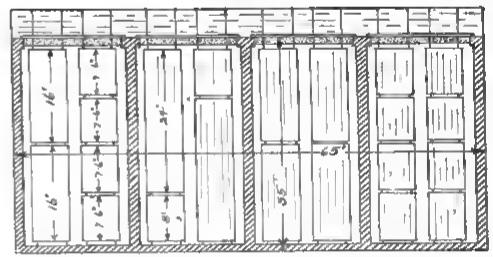


Fig 4

itself equally well to small loads of short boards, extra long loads, or the usual 16 foot stock. Fig. 4 shows a battery of box kilns equipped for endwise piling with various kinds of lumber indicated. Fig 2 showed a similar battery equipped for crosswise piling. In the crosswise piled kiln the lumber is not so accessible as in endwise.

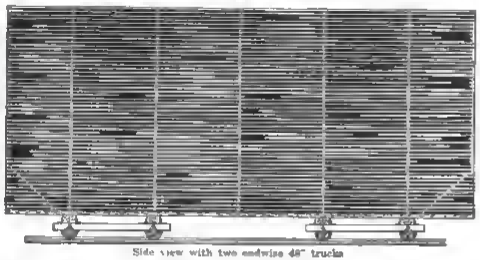
The methods of using trucks under kiln cars is shown in Fig 5.

It is rarely advisable to build kilns more than 10 ft. high

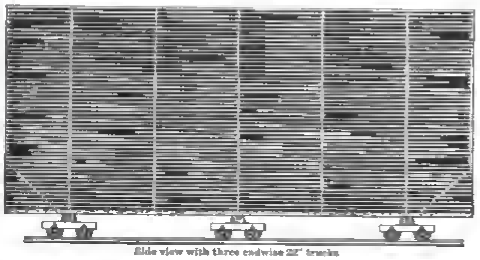
*This present article is the third of a series discussing the various phases of airplane lumber drying which have been contributed by the author to Aviation and Aeronautical Engineering. The two preceding articles, "Testing Moisture Content in Lumber" and "The Controlled Saturated Atmosphere Expansion Method of Lumber Drying," appeared in the issues of August 1 and 15 respectively

from top of rail to under side of ceiling. This permits loads of lumber 8 ft. 6 in. high, leaving about 9 ft. for trucks below and 9 ft. for top clearance.

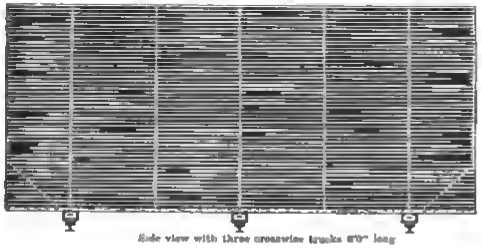
"Stickers" or "crossings" to separate boards on kiln cars should be not less than 1½ in. wide and dressed to uniform



Side view with two endwise 48" trucks



Side view with three endwise 32" trucks



Side view with three crosswise trucks 8'0" long

FIG. 5

thickness. Thick lumber requires stickers thicker in nearly the same proportion.

The following tables gives the holding capacity of kiln cars in standard board measure, each car being 6 ft. wide by 16 ft. long by 8 ft. 6 in. high above trucks, allowing ample space for ventilation (one third of horizontal area):

Thickness lumber	Size stickers	Courses	Kiln car capacity
1"	1" x 1½"	51	1 264
1¼"	1" x 1½"	41	1 936
2"	2" x 2"	28	3,528
2¼"	2" x 2"	23	3 696
3"	2" x 2"	21	4 032
3¼"	2" x 2"	18	4,256
4"	3" x 3"	13	3,840

There is no economy in trying to lay boards closer together nor to scrimp on the thickness of stickers. The end of a well ventilated load should appear as illustrated in Fig. 6.

Workmen will be careless about the proper placing of stickers and unless properly arranged in vertical columns the lumber will sag and be dried crooked. Devices similar to those illustrated will guard this point. The frame holding the forked guides can be raised and lowered to keep even with the point where workmen are piling lumber.

All illustrations and tabulations are based on *flat* piled lumber, although certain authorities advocate edge piling, because of the more equal exposure of the two sides of every board, and because of the increased kiln capacity possible when boards are placed with edges close together. In edge piling it is difficult to dry without warping or curling, as it is impossible to bring a sideways pressure that will be as effective as dead weight to keep all the boards flat.

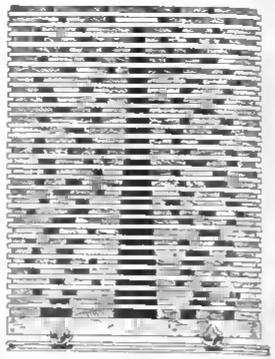


FIG. 6

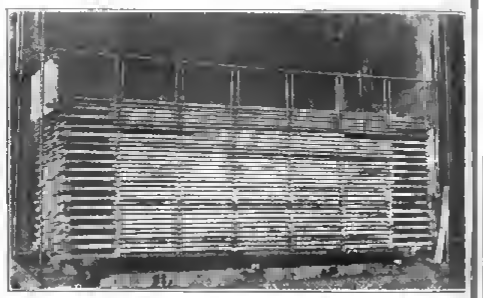


FIG. 7

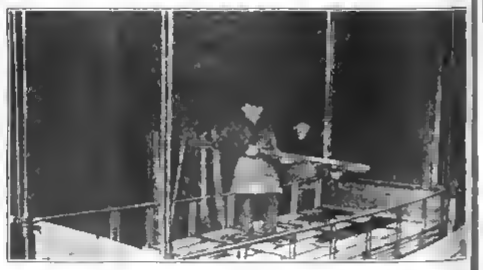


FIG. 8

Transfer cars can be obtained, for either endwise or crosswise piling, to facilitate the moving of kiln cars between loading tracks, kilns, dry storage and cutting room. Be sure the transfer cars you buy are built rigid enough, as a "slimpsy" transfer car is exceedingly annoying. Transfer cars are usually about one foot high.

The use of an endwise piling transfer car as applied to Fig. 4 is shown here. Adequate loading tracks adjoining the railroad siding, ample green storage for loaded kiln cars both make for convenience in handling lumber.

Dry storage space may be inside the factory if desired, but should always be kept at factory heat and humidity. Never try to include the dry kiln inside a building, put it outside in the yard, convenient to the railway sidings, and accessible to the boiler plant for steam.

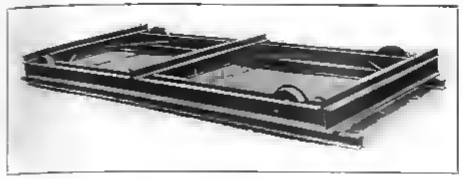


FIG. 9

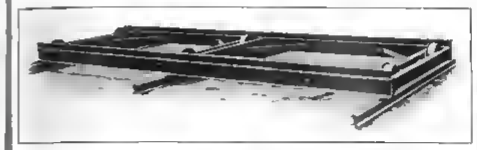


FIG. 10

Wooden doors, built of cypress, with a dead air insulating space are much better than curtains. The doors should be pliable enough to fit snug against the gaskets and to keep from warping. Don't hinge kiln doors as they are too heavy, and swinging doors take up too much room outside of the kiln. Special door carriers are made as illustrated, which lift each individual door up and out to allow it to be rolled in front of the adjacent kiln as illustrated in Fig. 12.

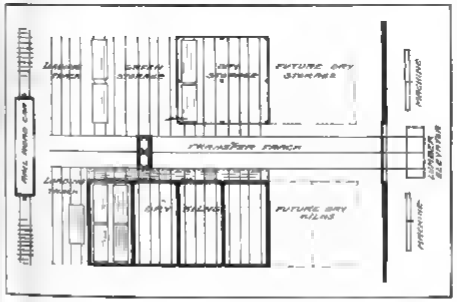


FIG. 11

Much time is usually wasted in taking lumber from kiln cars at the cut-off saw or planer. The process can be simplified and the wages of at least one man can be saved by the use of a lumber lift as indicated in Fig. 13.

This is in effect a quadruple jack screw, with a six foot range of elevation. The screws are threaded two right and two left and splined. On the lubrication setting are large nuts driven by bevel gears and sprocket chains. In this way the four screws are kept in simultaneous operation. The elevator is operated by either a belt from the line shaft or by a separate motor.

The sawyer lowers his fresh load of lumber until the top of the load is within a foot of the saw table. Then as the courses are removed and cut, the lift is raised, and at the finish the lowest courses of lumber are only a foot below the saw table. With this device a sawyer will cut more lumber, and do it easier.

Enough has been indicated in this article to suggest a few of the many problems confronting the prospective kiln purchaser. In any event go slow and give heed to those who are specialists in kiln design. Adopt a comprehensive plan and provide plenty of room for logical growth as your business develops.

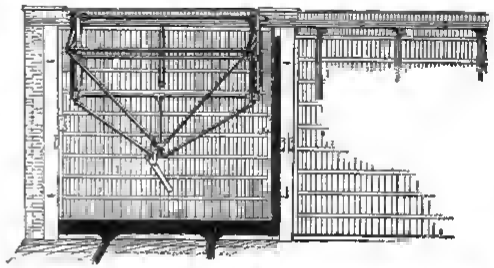


FIG. 12

FIG. 13

Editorial Note—The cuts and diagrams are used through the courtesy of the Grand Rapids Vapor Kiln, Grand Rapids, Mich.

Calculating Static Thrust of Propellers

I cannot help taking exception to the analysis proposed by Frank W. Caldwell, for calculating, even roughly, the static thrust of propellers. It seems to me that the phenomenon is so complicated that it is absolutely impossible to present it in a brief rationalized form of this kind, and the best that can be done would be to fall back on the results of experience and to see if any kind of continuity cannot be ferreted out from the actual results.

To begin with, we all know that Renard's formula suggests the fourth power of diameter, neglecting the pitch altogether. Then, some time later, Alexander Sée, in his attempts to rationalize Riabouchinsky's results, arrived at a somewhat similar formula, which seems to check up, pretty well, with the results of tests. Here, too, the pitch was not taken into account at all, in view, I suppose, of the fact that the very conception of pitch is rather hazy. But, of course, it was not meant that either zero pitch or infinite pitch would, too, come under the formulas proposed.

Why, therefore, not to seek the correct approximation in some such formula as

$$T = \frac{n^2 D^4}{2750}$$

where T is the static thrust, n the revolutions per second, and D diameter in feet. The constant, 2750, in extreme cases varies from 2200 to 3350, which leads to a discrepancy not exceeding the limits of 20 per cent each way, being therefore satisfactory for the purpose outlined by Mr. Caldwell.

The only trouble with such rough formulas is that some one may try to get out of them more than they actually are capable of giving, apparently forgetting that no satisfactory formula can possibly be given in a problem so exceedingly difficult.

N. W. Akimoff.

The World's Air Routes and Their Regulation*

By Col. Lord Montagu of Beaulieu, C.S.I., F.R.Met.Soc., A.I.M.E.

Advising Mechanical Inspector to the Government of India

Unless we are to have lawlessness and anarchy in the regions of the air there must be efficient control—this is an axiom of efficiency and civilization. Control of the levels can only be exercized, nationally and internationally, by police pilots on fast planes above the ordinary traffic, where, with the forces of gravity to aid, they can descend with a superior swiftness upon malefactors and breakers of the laws of the air, take their numbers or compel them to alight at the nearest landing place or drome.

There must also be no unsilenced machines regularly operating below 8000 ft.—I am not sure whether that limit is high enough—for even above that height the noise of many open exhausts and the hum of many propellers may become a continuous and nerve-racking nuisance. A serious amount of unpopularity and agitation against the use of unsilenced planes will have to be faced before long.

Now we come to the levels above 10,000 ft., which I propose should be internationalized. The upper air should, I think, be free to all, under certain regulations, provided pilots comply with certain rules for meeting and overtaking, and their craft passed as air-worthy—let us say, registered as A1 in a Lloyd's aerial register. This would follow the precedent, which has worked well, of the 3-mile limit at sea open to all ships of all nations.

Great altitudes will impose upon ordinary flying some disadvantages which will tend to keep international flying overland and overseas near the 10,000-ft. limit, and flying at these

levels will probably, so far as international flying is concerned, be conducted along routes to be defined by methods to which I will allude presently, and in some cases nations may agree to admit international traffic to its own levels. But if a particularly cantankerous nation objects to admit any traffic to the lower levels below 10,000 ft., the air routes will not be altogether barred.

It is clear, also, that there will be prohibited areas, naval and military centers, and flying over thickly populated districts will probably be avoided on account of a certain risk to those who are still content to crawl about on the earth. But, of course, this will not preclude, as I have said, the air liners of different countries using the lower levels when necessary under license from the countries over which they pass. Then, postal and passenger services may sometimes be driven down to lower levels owing to stress of weather.

Aircraft desiring to leave their own levels will, of course, use their wireless to ask for permission from national or international flying authorities. But in this case they should conform, at least so I think, to the rules for silence and any other restrictions which may be found necessary in the lower levels to ensure the peaceful enjoyment of the earth's surface by its inhabitants. The problem of how to secure law and order on overseas routes is more difficult, and for this purpose it seems to me that we shall have eventually to define the paths to be followed within, say, certain degrees of latitude and longitude.

It is here again that international control will be necessary, and this control must be backed by international force in the shape of air police, for without force behind them conventions and international arrangements are as futile as the resolutions of The Hague Convention have proved to be. It may be, therefore, that flying over the sea outside the 3-mile limit will become a question of routes outward and homeward, with no exactly defined air levels or a fewer number of levels.

I now come to the question of how the routes chosen over continents are to be defined and traffic guided by night and by day, also how landing places are to be constructed and defined. Here, again, I think we may follow the long and proved experience of the sea. It happens that we possess a more or less agreed code of buoys and marks for defining channels, which I suggest should be imitated in the matter of the air. On the right hand, or starboard, side of all routes from the west to east, the direction in which the earth turns, there should be round marks—a white ring containing a black center.

Routes emanating from westerly points would be those whose general trend is between north and south on the westerly side of the compass. To take, for example, the routes from America to Ireland, Great Britain to Russia or India, Japan to Alaska or British Columbia, Brazil to the West Coast of Africa—on these the starboard, or right-hand, marks on land and sea alike will be white circles with a black center, while on the left, or port, side would be checker marks as shown here, square in shape.

At sea a system of large buoys may be necessary, where the depth of the sea is not too great for anchorages. And these marks, I may observe, will have to be of considerable size, probably at least 100 yards in diameter, for at 10,000 ft. these will appear dots on the earth's surface.

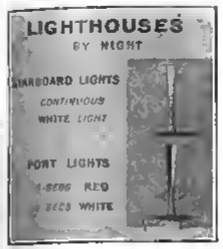
At night routes may be defined, as you see on these diagrams, by a continuous white light on the right, or starboard side, and red and white alternating lights on the left, or port side. These international and national routes, between countries, parts of a country, and continents should be of a minimum width of 5 miles, and in some cases a space of 10 miles may be a more suitable width when the air eventually becomes crowded. But that time is some way off.

Dromes and landing places may have to be convex and circular, on the plan shown in the diagram. The advantage of this will be that every airplane alighting will have, running uphill, the force of gravity to arrest its motion, and when starting off again, the force of gravity will equally help to give it speed to rise from the ground.

At night the principal light which will illuminate the special places will, of course, show its rays up wind, so that the pilot who is obliged to head against wind will have the light at his back and not at his face when making his landing. There must also be lights denoting the starboard and port sides, smaller green and red lights on each side of the portion of the ground on which landing is advisable.

All these lights should be movable, and be placed on trucks on rails laid down round the circumference of the landing ground, so that they can be moved as the wind shifts from one quarter to another, and in the daytime they can be moved in conjunction with indication marks to achieve the same purpose. Different routes would be indicated by large white arrows on the ground with, perhaps, the initial letter E or W to say in which direction the routes were proceeded. At night such arrows would be illuminated.

The marks and lighthouses could be at intervals of 10 miles, alternately each side, or 20 miles apart on the same side, as shown on the diagram, and in the case of fogs these lighthouses will help, like those concerned in navigation by sea with wireless telegraphy and toned fog-horns. There will also be assistance given by at least two new and very important developments of wireless telegraphy, by which direction of bodies in motion can be accurately ascertained by the helmsman or pilots and their position in regard to fixed points on sea, land, or in the air easily ascertained. I cannot give any more precise indications at present of these new developments, which promise to be of the greatest assistance in the navigation of the air in the future. In fact, when perfected they will deprive night fog and cloud of most of their dangers.



Over the sea lighthships will be usable with the same code of lights always turned upwards. There may also be on land small captive balloons at moderate altitudes illuminated at night to indicate locality to the upper levels.

GRADIENT POINTERS

Now we come to some minor, but still important points, such as to how mountains are to be surmounted. You will remember that I expressly mentioned that the "levels" should be measured from the surface of the planet, not from sea-level calculations. It follows, therefore, that when you have to cross passes through mountains, such as the Himalayas, Alps, Pyrenees, or, to come nearer home, to fly over such mere pimples in comparison as the Pennine Range, the Cheviots, or the Grampians, there will have to be some signs to show that you are nearing "rocks." Of course, to save motor spirit (probably distilled by them from coal direct, and no longer petrol), the lowest passes through mountain chains will be selected. The world's traffic lanes will, therefore, not be at the same altitude all over the world reckoning from the sea level. They will vary except over flat countries.

Let us take an instance near home, the nearest route from Newcastle to Edinburgh—over Carter Fell into Scotland—will necessitate a rise of just under 1,600 feet. Without proper warning and on a misty day or dark night, an airplane flying to the east of the point where the border is crossed might collide with the Great Cheviot, which is nearly 3,000 feet high, or nearly touch Carter Fell itself to the west of the pass. There must be, therefore, intimations of gradients similar to the gradient posts of railways.

I propose that ascending and descending gradients should be made clear. These would be white patches by day and their outlines illuminated by night. Then you may legitimately ask at what level will your need for higher altitudes for your levels begin. I suggest that all altitudes from sea level to 250 feet should be considered as negligible. Above that, every 250 feet will be indicated by large figures giving the average altitude of the ground below, 500, 750, 1,000, and so on. It will be desirable, in planning regular routes, to avoid isolated high hills or groups of hills, small in area, such as Hindhead or the Malvern Hills. All routes will follow so far as possible flat country for meteorological reasons as well as I shall show presently.

HOW AIRCRAFT SHOULD BE MADE IDENTIFIABLE

Now I come to the problem of how planes shall be designated and made identifiable. First of all there will be the nationally arranged colors of each country for those engaged in official services. Then I propose that all private planes shall be white and commercial planes red to distinguish them the one from the other. All planes, official and private, will be lettered and numbered, as decided by some international conference, such as that which settled for all countries the regulations for international motor car touring, and which allotted to each country specified lettering—GB standing for Great Britain, F for France, and D for Germany.

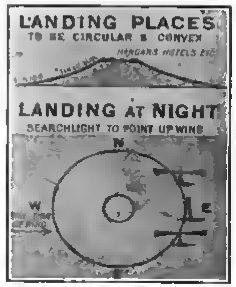
Pilot certificates granted by responsible countries will be recognized as valid by all those countries which signify their adherence to an international agreement, in the same way as motor drivers' licenses are now recognized everywhere.

Almost the most important of the subjects which will have to be considered in relations to the world's air routes is how weather and wind conditions will affect flying over the surfaces of this planet. The prevalence of trade winds is known to you all, and how they blow with unvarying regularity and strength in certain directions in certain seasons. But what is less generally known is the almost permanent existence of areas of highly barometrical pressure (sometimes called anti-cyclonic systems) in different parts of the world. These systems, though they contract and expand, have a more or less continuous effect upon the weather and winds of the world.

WIND AND WEATHER ALL IMPORTANT

Before these charts of pressure and winds can be properly understood, there are two points that must be grasped. Firstly, that wind always blows parallel to the lines of the isobars, that is, the lines of equal pressure, and, secondly, that the circulation of the wind is clock-wise in high-pressure or anti-cyclonic areas and anti-clock-wise in low pressure or cyclonic areas. This is known as the Buys Ballot Law, which in the southern hemisphere equally applies in an opposite sense.

Now you will observe that the weather of Western Europe, with which we are mostly concerned, is largely governed by two factors, the tendency to a low pressure trough more or less, all the year round, between Greenland and Iceland, and the high pressure area, which is permanent, though varying in area near the Azores. There is another seasonal high pressure area in the Sahara over North Africa, between the West Coast and the Sudan, during the winter time, as has just been proved by Major Lyons, the President of the Royal Meteorological Society, in a recent paper. Then there is a nearly constant area of high pressure north of the Himalayas, over Southern Siberia and Turkestan.



The low-pressure systems in the European and Western Asian areas are more seasonal and variable in character. There is a trough of low pressure, which lies between the Persian Gulf and the Western Himalayas, between May and October, which is the origin of the southwest monsoon so strongly felt in the Arabian Sea and over the western and northern parts of India. Then, nearer home, there is another area of low pressure generally prevalent over the Adriatic, the Northern Mediterranean and the Balkan States, which is characteristic rather of the winter than the summer months, producing a tendency to westerly winds in the Mediterranean and corresponding easterly winds to the northward of the Carpathians.

Now the systems, and the consequent tendencies to a permanent direction of wind either all the year round or at certain well-defined seasons, have a most important bearing on the world's air routes. For instance, the route homeward from India during the greater part of the year will be far easier through Afghanistan, Russia, Germany, and by what I may call the northern route, than by a more southern course, for easterly winds or calms predominate. On the outward or eastward journey, however, the route is across France, by the Rhone Valley, where the wind is often northwesterly, sometimes called the "Mistral," to Marseilles, whence we shall go either across the lower Alps to Italy, and follow the coast to the heel of Italy. Or we shall fly via Sardinia to Malta, whence by Tunis we get to Egypt.

The alternative routes will be from Brindisi to Alexandria direct about 900 miles, or from Taranto to Malta. Thus the eastward and westward routes to India, the Central European and Mediterranean may be spread apart by a thousand miles at their extreme point of divergence, and yet be the quickest routes and the cheapest to fly. In fact, wind will matter far more than mileage.

EASTERN ROUTES AS AFFECTED BY WINDS

Now let us take the outward Eastern route in detail and see how the winds will help on an average winter day. Starting, say, from Hendon or, perhaps, Croydon—for I assume that

* Extracts from a paper read before the Aeronautical Society of Great Britain, June 21, 1917. Continued from the last issue of AVIATION.

two great starting and landing places will exist for northern and southern routes to and from London—in the first flight Marseilles will be reached, where a descent for lunch will be made, the 600 miles—I give round figures—having been covered in about five to six hours. This portion of the route will be affected on about 80 per cent. of the days of the year, first by westerly and later by northwesterly winds, that is, either cross or negative and favorable currents.

Next, some point near Taranto or Brindisi or at Malta itself will be the next stopping place. This part of the journey will probably be done by seaplane in order to avoid the longer route round the Bay of Genoa and the leg of Italy. The prevailing wind over this section will be northwest to start with, and afterward light airs from the southwestward will be encountered. The "mistral" often extends in a modified form on many days in winter to a point as far as the south end of Sardinia, where the more westerly current supersedes it. The winds on the first day will, therefore, be favorable on the average.

SECOND DAY'S JOURNEY

On the second day, whether we start from Brindisi for Alexandria direct or fly via Malta and Tunis or Tripoli, a westerly wind will prevail, as a rule, near the African coast, though a moderate easterly wind is sometimes met with in the neighborhood of Malta from September to April.

On this second day's journey, by evening you will have reached either some point between Malta and Alexandria on the Tripoli coast, or more likely Alexandria itself, only 850 miles from Malta. Egypt is situated in a region where calms or light winds predominate, with the exception of the disagreeable sand-laden "Khamseen," the strong westerly wind from the desert, which, however, is favorable to progress eastward.

We then proceed eastward over the Arabian desert, where calms and light winds are the rule, a state of atmosphere which prevails all the way to Karachi, except in the monsoon period, when the northwest wind is also in our favor. In the Persian Gulf the isobars for the greater part of the year show a prevalence of northwesterly currents, also favorable. At Karachi in the winter, during the day, wind of considerable strength from the southwest is produced by the great difference of temperature between the Arabian Sea and the heated areas of the Sind desert behind it. Flying on southeastward toward Bombay or northeastward toward Delhi, there is no decided unfavorable current on the average.

REVERSE WINDS FOR HOME PASSAGE

I have not time to examine in detail all possible routes, but on the homeward passage, the reverse side of these winds, favorable for flying eastward is available. There is no doubt about the prevalence of easterly and southeasterly winds throughout the monsoon period, lasting from the middle of May to the end of October, in all the country we should use for our westward journeys through Afghanistan and through the neighborhood of the Aral and Caspian Seas.

Our first day's journey homeward takes us to Gurieff, following the average isobars. And once the corner of the Hindu Kush has been crossed at about 5,800 feet, the country all the way to England is marvelously flat, which favors the absence of wind.

The next day we leave the head of the Caspian Sea, and arrive via Lugansk et Tarnopol near Lemberg. Here, again, we leave the mountain systems of the Caucasus, the Balkans, and the Carpathians to the south of our route. The next and third day we have to face the chances of westerly winds against us when approaching the North Sea and Channel, which, however, lose much of their force inland.

THE WIND OUR FRIEND

Of course, there will be special atmospheric conditions from time to time which will involve alteration from the average courses recommended for over sea and over-continental flying. There may be, to take a common instance in summer, an extensive "low" over France or over the mouth of the Channel involving strong easterly winds blowing from our western shores far out into the Atlantic to a point at which the Azores "high" is joined up with another "high" near the Atlantic coast.

In such a case a seaplane could, with the probability of a favorable wind over the greater part of the passage, fly from County Kerry to St. John's, Newfoundland, in a shorter time and with less expenditure of petrol than by any other route. And in flying westward you will be sun-chasing.

In our English latitudes of 51 to 55, the earth's motion does not exceed about 650 miles an hour, and though we shall not be able to fly quite fast enough yet round the planet to keep the sun over our heads continuously, still at 120 miles an hour we shall lengthen our day very considerably.

In the case of crossing the Atlantic there will be a gain of about four hours between Ireland and Newfoundland, which means that leaving Ireland at 7 a. m. on a summer morning, if an average of 110 miles an hour is maintained, you will reach St. John's in 16½ hours actual elapsed time, from which four hours must be deducted in point of solar time. Thus you will leave Ireland after breakfast at 7 a. m. and reach Newfoundland at 7.30 p. m. by local time in time for dinner. Coming eastward, your daylight will be shortened by the same time and, except in the summer months, a start before dawn or an arrival after sunset will be inevitable.

I cannot deal on the present occasion with other weather conditions such as fog, except to mention that fog exists chiefly in certain latitudes and generally coincides with calm weather or, at any rate, very light winds. Rain, snow, and hail I disregard, for they will be negligible to the planes of the future, though large hailstones may be harmful to propellers or even wings, but hailstorms are local, as a rule, and can be avoided. The ability also of airplanes to avoid or rise to a height above local disturbances will be the solution of many of these difficulties, for heavy precipitation, generally speaking, arises at levels lower than 10 000 feet.

A GENERAL LAW FOR FLYING

Applying the results of the Buy Ballot law, we arrive at another proposition, which will be accepted by meteorologists, that when the weather at any spot in the northern hemisphere is under the influence of low-pressure areas, and if the passage of the centers is near the place from which the pilot is flying westward, he will start on a northerly course at first. In like manner, when he desires to fly in an easterly direction, he will take a southerly course to start with. If, on the other hand, the weather is under the influence of a high-pressure area, these rules will be exactly reversed.

There is another point which every experienced pilot is aware of but which is not generally known to the public. The higher you fly the more the wind tends to turn to the right. That is to say, if on the ground you find a westerly wind, the wind at 5,000 feet will probably be W. N. W., and at 10,000 feet probably N. W. The cause of this is found in the rotation of the earth, but I cannot dilate on this here.

Now I come to the conclusion of my lecture, and I desire to summarize the principal points.

THREE POINTS OF IMPORTANCE

Firstly—As soon as war is over there must be national and international laws for the regulation of flying.

Secondly—Over-sea and over-continental routes must be defined in the interests of the whole world.

Thirdly—The winds of the world, instead of being a drawback to flying over the surface of the planet, will, if properly used, prove to be of great assistance.

LIFE AND MONEY SPENT ON AVIATION NOT WASTED

The progress of aviation, owing to its immense and increasing importance in the war for naval and military purposes, has been extraordinarily rapid during the last three years. The decisive military and naval results which a real preponderance of air power would bring about are at last beginning to be realized. Nations are spending millions of money upon the development of flying, and thousands of brave men have sacrificed their lives, both in fighting and experimental work. There has been a prodigal expenditure of life and treasure, and a wonderful concentration of brains and energy on aviation for destroying human life and wrecking property. But when peace once more comes, this output of human life and skill will prove not unproductive. Unlike the expenditure of all kinds on producing forts, battleships, guns, shells, powder, missiles, gas and horrible and ingenious ways of killing, resulting in nothing useful to the human race in future, the forced development of aviation will, perhaps, be the war's most useful legacy.

STANDARD

WITH THE PURCHASE AND OCCUPATION OF THE ABOVE
FIELD AND WATER FRONTAGE, THE STANDARD AERO CORPO
UNDER ONE ROOF IN THIS COUNTRY, THE PLANT, FORMERLY
FROM NEW YORK CITY GIVING COMPLETE ACCESS TO THE
ESTABLISHED, AT THIS TIME, WHEN OUR RESOURCES

STANDARD

IN THEIR ENTIRETY, COVERING NINETY ACRES, WITH FLYING
RGEST AND MOST COMPLETELY EQUIPPED AIRCRAFT COMPANY
IS SITUATED AT ELIZABETH, NEW JERSEY, FIFTEEN MINUTES
OR MARKET IN THE WORLD WE ARE GLAD TO BE SO FULLY
LLY AID THE AERIAL PROGRAM OF OUR COUNTRY

Digest of the Foreign Aeronautical Press

***Espana Automovil* (Madrid), July 15, 1917**

On Aerial Warfare—Captain Herrera, of the Spanish Army, who was recently given an opportunity to visit the French and British air fleets on the Western front, gives the following details on the aircraft he was permitted to examine.

The fighting airplanes of both the French and the British are, as a rule, small one-seater tractor biplanes in which the functions of the pilot coincide with those of a gunner. The armament consists of one, two or even three machine guns which mostly fire through the propeller by means of a synchronizing service. In this case, in order to aim, the whole machine must be directed on the target.

Such are, in the French aviation service, the Blériot and Spad biplanes, which are fitted with a 150 hp. or a 200 hp. Hispano-Suiza stationary engine, and the Nieuport biplane, which carries a 150 hp. Le Rhône rotary engine. All these machines are capable of attaining speeds of from 190 to 210 kilometers per hour.

The British Royal Flying Corps employs, besides the above described Nieuport, chiefly Sopwith biplanes and triplanes fitted with a 130 hp. Clerget rotary engine.

The French employ, however, numerous two- and three-seated pusher biplanes which mount much heavier armament, namely, 37 mm. and 47 mm. Q. F. guns; these are to be found on the three-seater Voisin (200 hp. Peugeot or Hispano-Suiza) biplane and on the two-seater Brégnet (250 hp. Renault) biplane. These machines are chiefly employed for patrol work around large cities which are within raiding distance of the enemy. They are provided with a particularly sturdy chassis and a special lighting system enabling them to start and land by night. These features cause them also to be used to a great extent for night bombardments, but in such case it is usual to carry lighter armament, that is, one or two machine guns only.

The Royal Flying Corps employs for bombing chiefly the 130 hp. Clerget engined Sopwith biplane, a two-seater, mounting two machine guns, firing fore and aft, respectively; the Handley Page biplane, fitted with two 280 hp. Rolls-Royce engines; and the one-seater Martinsyde (140 hp. Beardmore) biplane.

While the British use many of their fighting and bombing machines for reconnaissance work, the French specialize airplanes for the latter function. Among the French reconnaissance airplanes the most noteworthy are the 160 hp. Renault-Farman pusher biplane, a two-seater mounting one or two machine guns, the Letord biplane, fitted with two 150 hp. Hispano-Suiza engines which mount four machine guns, two of which can fire forward and two aft; and the three-seater Moneau biplane which carries a similar battery and is propelled by two 240 hp. Canton-Uné engines.

Captain Herrera finally notes that besides small non-rigid airships, the rigid Zeppelin type with two engine cars, a connecting gangway, and four lateral propellers, is now also represented in the airship fleets of the Allies.

***Flight* (London), August 9, 1917**

One Air Service, One Uniform, One Badge—An editorial indicative of the widespread agitation going on in England regarding the unification of the Royal Flying Corps and the Royal Naval Air Service into an Imperial Air Service.

"Instead of recognizing the obvious and doing what will have to be done sooner or later, the Government goes on with its attempts to reorganize the air services on a basis which the tests of war have shown to be radically unsound.

"It is unsound, no matter from what point of view it is regarded. In the wider operations of the war it has failed in strategy, in that it has no strategy. It has created a line of demarcation between the two fighting branches which has been productive of endless jealousy and friction. It has been wasteful of money and it has shifted output, so that the country has not even received decent value for the money that has not been actually thrown away. All along the line the system has been a proved failure—and yet we keep on attempting to "reorganize" instead of getting rid of it, root and branch, in favor of the scheme that *would* work. * * * Opinion is unanimous that there is only the one thing to be done—to carry out at once the policy which is embodied in the words which head this article."

***Flying* (London), August 1, 1917**

The Battle for Observation. By Hilaire Belloc.—Since war became an organized affair every action has consisted of two parts, namely observation, and the piercing or turning of a line.

Observation means (1) offensively, the knowledge of what and where your opponent is, and (2) defensively, the prevention of your opponent knowing what and where you are. Until the advent of aircraft, observation was effected by the examination of prisoners, reports of spies, and the feeling out of the enemy by a screen of cavalry spread out in front of your own army.

With the advent of aircraft, observation became a different matter. Aircraft permitted you to see nearly all that the enemy was doing in fair weather during daytime, to photograph his positions, and to embarass him by bombing his communications and stores.

But this increased power of observation brought about a novel condition in warfare, that of fighting the enemy in order to prevent him from getting similar observation. Unlike in the old days of cavalry action no screen can be established in the air, where the three-dimensional movement of aircraft enables the enemy to escape above or below your action.

There exists then today a thing undreamt of three years ago, the battle for observation. This has taken on functions outside itself. The aircraft force which wins over its opponent the power of observation is also essential to the management of guns. For observation nowadays not only tells you what the enemy is doing and how he stands, but also directs—is essential to directing—your own fire.

Therefore, *to win the battle in the air is an absolute condition of success* not only in the function of observation and the regulation of artillery preparation, but also as an adjunct to the advance when airplanes support the infantry.

***Flying* (London), August 8, 1917**

Raid Risks and Street Risks.—The Home Secretary is authority for the statement that since the beginning of the war up to date more than six times as many persons have been killed and more than sixty-seven times as many persons have been injured in street accidents in the London metropolitan area as in air raids. The official figures are the following:

	Killed	Injured	Total
Air raids	366	1,092	1,458
Street accidents	2 412	70 863	73,275

The moral is, says *Flying*, that pedestrians should read the warnings issued by motor-'bus companies as carefully as the warnings issued by the police with regard to air raids.

***L'Aerophile* (Paris), July 1-15, 1917**

Aerial Mail Routes—The Italian Ministry of Post and Telegraphs inaugurated on June 27 a daily postal seaplane service between Continental Italy and Sardinia on the line Civitaveechia Terranuova. Each seaplane carries 200 Kilograms (440 lb.) of mail and covers the trip in approximately two hours.

The success of this service has prompted the French Ministry of Post and Telegraphs to organize an aerial mail route between France and Corsica. For this service military machines inapt for war service but otherwise efficient as weight carriers will be employed.

The administration of Algeria has just concluded an inquiry regarding the establishment of an aerial mail service across the Sahara Desert. It is ultimately intended to open a postal airplane route between Paris and Timbuctou, the total flying time is to be 30 hours and relay stations will be provided at Marseilles, Algiers and In-Salah.

***The Aeroplane* (London), August 1, 1917**

On Some Directions for Reform—The enormous wastage of lumber and of labor in the manufacture of four-bladed propellers causes an anonymous English propeller maker to make the following suggestions for the economizing of material and man-hours.

"It is quite an easy matter to economize fully 80 per cent of the timber and to increase the output by 120 per cent, by

abandoning the geared down four-blader in favor of the direct driven two-blader

"A two-blader made (in England) for the 150 hp Hispano-Suiza-Spad gave, in competition with the leading French and English propellers, the best climb and horizontal speed, and had a diameter of only 7 ft 8 in., with a weight of only 17 lb., and the amount of timber used (averaged over 100 propellers) was 26 superficial feet per propeller. The time required for shaping was less than 25 hours

"This compares very favorably with any of the official designs. The R.A.F four-blader propeller for the R.A.F 4a engine of less power, for instance, requires over 120 superficial feet, and takes 75 hours for shaping

"A better designed four-blader for the same engine would require about 90 ft super. of mahogany, but if the propeller speed was increased, a smaller two-blader, requiring not more than from 30 to 40 ft. super. could be designed to give quite satisfactory results."

To remedy this wastage, the following recommendations are made:

(1) Increase in propeller speed instead of gearing down.
(2) Two-blader propellers only
(3) Alterations in principle of design The propeller design on present principles, although adopted over the whole world, does not seem to give the best results that can be obtained, experiments conducted by the manufacturer mentioned seem to indicate that a slightly different principle of design gives better results.
(4) A standard engine-boss fitting, with a bore of not more than 70 mm. for all propellers absorbing less than 350 hp.
(5) Scarf and half-lapped joints to be allowed as in French propellers The present (English) practice of using joints in two-bladers (apparently for variable pitch.—Editor) is dangerous and does not save material.
(6) Glueing up *en bloc*, which is used by some firms, to be generalized.

Tohili (Mexico City), August, 1917

Cross-country Flight of Mexican-built Airplane—On July 6 a Mexican army biplane, piloted by Captain Horacio Ruiz, chief-pilot of the Valbuena Military aerodrome, made a cross-country flight from Pachuca, Hidalgo, to Mexico City

Particular interest attaches to this flight because it was made by a Mexican built airplane, the machine being a product of the National Aviation Works of Mexico City. The machine is a tractor biplane and it fitted with a 150 hp Hispano-Suiza engine. During the flight, which lasted 58 min. 42 sec., an altitude of 1400 m (4600 ft) was reached. A mail bag containing 534 letters, 67 postal cards and second class mail was carried on the trip.

The Witteman-Lewis Training Tractor Airplane

The Witteman-Lewis Aircraft Co., of Newark, N J, has recently produced a two-seater tractor biplane, called Model TT, which is specially designed as an advance training machine for military aviators.

The characteristics of the machine as given out by the manufacturer follow:

GENERAL SPECIFICATIONS OF MODEL TT

Span of upper plane	42 ft.
Span of lower plane	34 ft
Overall length	27 ft 2 in
Overall height	9 ft. 8 in
Chord of upper plane	7 ft 9 in
Chord of lower plane	5 ft. 6 in
Curve of upper plane	W L No 7
Curve of lower plane	W L No 7
Gap	5 ft 8 in
Dihedral angle	1 deg 30 min
Area upper plane, exclusive of ailerons	223.21 sq ft
Area lower plane exclusive of ailerons	206.9 sq ft
Area ailerons (2)	38 sq. ft.
Area horizontal empennage	51 sq ft
Area vertical empennage	17 sq ft.
Span of empennage	10 sq ft.
Area total supporting surface, inclusive of ailerons	392 sq ft
Loading per sq ft	6.48 lb
Loading per sq ft	23.88 lb
Weight of airplane, without power plant fuel or load, but including main planes, body fuel tanks, chassis, control and auxiliary surfaces	1040 lb.
Weight of power plant, including motor complete with radiator, cooling water propeller, starting handle and other accessories but without gasoline or oil.	490 lb
Useful load including pilot (165 lb), observer (165 lb), tools, parts, supplies etc	390 lb
Fuel load gasoline and oil for four hours' flight at full power	240 lb
Total gross weight	2130 lb.
Engine	Hall Scott A7a model
Horsepower	90 hp at 1300 r.p.m.
Propeller	Walnut, Hall Scott
Diameter	8 ft 7 in.
Pitch	5 ft 8 in.
Direction of rotation	Left hand
Control	Dep

Standard equipment Fire extinguisher tool kit, assortment of fittings and parts, propeller and cockpit covers Instruments as follows Air speed meter altimeter clock oil and air pressure gages tachometer, thermometers, primer shut-off valves, hand air pump and ignition switches and carburetors and magnetic throttles.

Aeronautical Patents

Copies of these patents may be obtained for five cents each by addressing the Commissioner of Patents, Washington, D C

ISSUED JULY 31, 1917

1,234,727 Filed Oct 9, 1915 To John W Cuarike, Coldwater Mich Flying machine.

ISSUED AUGUST 7 1917

1,235,856 Filed Jan 4 1919 To Frank Ezra Summers, Memphis, Mo Ornithopter

1,235,988 Filed June 22, 1916 To Thomas R Macmechen and Walter V Kamp, New York N Y Airship

News of the Fortnight

Glenn L. Martin Organizes Company

Glenn L. Martin, the airplane pioneer of Los Angeles, Cal, and late vice-president of the Wright-Martin Aircraft Corporation of New York City, has just organized a company for the manufacture of aircraft at Cleveland, Ohio.

The company, it is announced, will have a capital stock of $2,500,000, all of one class, all shares to be sold at par value There will be no bonus stock of any nature

A number of prominent Cleveland business men are supporting the company.

Chas E Thompson, president of the Steel Products Company of Cleveland, Ohio, is to become president, and Mr Glenn L. Martin will be vice-president, of the new company. The board of directors will be made up of S. L Mather, C W Bingham, Chas E Thompson, W G Maher, Glenn L Martin, Carl N. Osborne and Caleb S Bragg

Standardization Committee Meeting

The International Aircraft Standardization Committee met at the Bureau of Standards in Washington on August 21 and 22. Those attending the meeting were Frank G. Diffin, United States, chairman, P. D Merica, Bureau of Standards, U S, secretary; Frithiof G Ericson, Canada; Captain A. Pomilio and Dr J. S MacGregor, Italy; Dr. G. K Burgess, Bureau of Standards, U S, George L Norris, United States Signal Service, Lieut M Mignot and Captain Jean Herck, France, A B Rogers and S G Payne, England, and Captain D. E. Chanvalon, France.

Among the important matters announced as a result of this meeting is the statement that each Allied Government will appoint official representatives as permanent members of this committee These representatives will designate members of their personal staff, appointing experts on the various subjects under consideration to attend the different meetings

It is understood that the Committee will meet Thursday and Friday of each week at the Bureau of Standards, which is designated as the official headquarters.

It is reported that considerable work has been accomplished in standardizing the materials used in airplane construction, and it is anticipated that, with meetings scheduled for each week, announcements of the adopted standards will be forthcoming shortly and that official specifications will be available for distribution

The meeting last week was devoted largely to steel specifications and the standardization of non-ferrous metals, particularly bronze, used in the manufacture of turn-buckle sleeves, bolts, and other parts, as well as aluminum for castings. All small accessories of this nature, which will be manufactured in large quantities and used to a great extent in all the airplanes of the Allies, are to be made uniform, so that they can be readily supplied or interchanged at a moment's notice.

Metal materials, samplings, analysis, instruction concerning physical tests of metals, selection tests, and methods of inspecting raw materials were considered The Committee's specifications will be based largely on the practice standardized by the American Society for Testing Materials, which specifies standard methods for inspection of raw materials

During the course of the meetings the subject of fabrics came up for a short discussion, specifications being considered, although this will not come up for a very full consideration until the next meeting, August 23 and 24. Under this division of the work, the material used for covering wings and rudders will be considered Linen is, of course, almost universally used, but owing to the fact that linen of a suitable quality is not produced in this country, extensive tests and investigations are now under way to determine the production of a suitable cotton fabric which may be used for this purpose. The work on specifications for iron, steel, aluminum, brass, and bronze parts and fittings for airplane construction is well advanced, and it is expected that an announcement of the requirements will be forthcoming shortly Meanwhile, preliminary standardization work is under way on other materials used in construction work

P. D. Merica, of the Bureau of Standards, has been designated as the secretary of this committee.

The U. S. A. Engine Tests

Tests of the first of the standardized United States airplane engines designed and built under direction of the Aircraft Production Board make it practically certain that American-made fighting machines will be available for service in France early next year Results from several tests have been highly satisfactory, it is learned, although details of the design and performance of the engines are withheld

The first engine produced was employed exclusively as a model from which gages and fixtures could be made, so that numerous factories could be equipped to turn out in great quantities various parts of the engine The progress of this element of the work indicates an early supply of the engines for service at the front.

Meanwhile the engineers are making every effort to improve the design and incorporate new features. As rapidly as improvements are developed they will be incorporated in subsequent engines, the same efforts toward quantity production being made each time the design is altered

Aviation Supply Depot at Middletown

Laborers have started getting the 21-acre plot of the Keystone State Fair grounds near Middletown, Pa., into shape for the construction of a building 364 x 901 ft, to be used as an aviation supply depot A 40-ft runway will surround the entire building Gannett, Seelye & Fleming, Harrisburg, Pa., engineers, in charge, estimate the cost of the work between $400,000 and $500,000.

The first building to be erected will be used as a supply depot for the assembling and distribution of air and water craft, wireless apparatus and machine-gun parts This will be followed by the erection of an airplane and seaplane factory on adjacent ground.

China Seeks Aid in Training Army

China soon will seek the advice of the United States and the Entente Powers on the best way to cooperate in the war with Germany.

It had been believed that Japanese officers would have the task of training China's army, but it now appears that the United States, Great Britain and France, as well as Japan, are to be requested to send military experts to China

Russia Needs American Aviators

General Zahubovsky, president of the Russian Supply Committee in the United States, recently said:

"What we should like to see on the eastern front as soon as possible is 1,000 trained American aviators, with machines, and 1,000 ambulances. In these two branches of the service America's help will be of the greatest value.

Flying at Canal Zone

A temporary flying field has been established at a point in the Canal Zone where hangars and storehouses have been erected. The Canal Zone is not suitable to the operation of land machines, and it is almost impossible to find suitable landing fields. Captain Tussell is the acting department aeronautical officer, Canal Zone

I. W. W. Menaces Airplane Work

It is feared the activities of the I. W. W. in the spruce producing regions of Oregon and Washington already have wrought serious damage to the Government's plans for the speedy construction of airplanes. Agents have found that injuries to the timber and to the machinery used in the fabrication of the wooden parts of the airplanes already has been accomplished.

The Administration's method of dealing with the I. W. W. will be an enactment, which is virtually an amendment to the existing espionage law, which provides punishment for persons engaged in seditious conspiracy to obtain breaches of contract with the United States

Dayton-Wright Propeller Factory

The Dayton-Wright Airplane Co, Dayton, Ohio, has purchased the three-story plant of the Enterprise Carriage Co, at Miamisburg, Ohio, and will fit it up for the manufacture of propellers.

Huge Orders for Spruce Placed

Initial orders for airplane spruce aggregating 1,000,000 feet a month were placed in Portland, Ore., by the United States.

This business, as well as all subsequent airplane business to be placed here by the Government and the Allies, will be handled through the newly organized Spruce Lumber Manufacturing Bureau, which has been formed for the expressed purpose of co-ordinating all spruce deliveries to the allies.

The bureau has established headquarters in the Yeon Building, Portland, Ore., with F. A. Douty as chairman and J. P. Keating as secretary. All spruce mills in Oregon and Washington are members.

All the business will be placed by Mr. Allen, representing the allied governments, with this bureau and redistributed by the bureau among the member mills in proportion to the capacity of each individual plant.

The price has been fixed, tentatively, at $105 a 1,000 feet. This arrangement will be tried for a period of 30 days, and if satisfactory all around at the end of that time it is expected to be continued indefinitely.

New Curtiss Plant Will Be Ready Soon

The immense new plant of the Curtiss Aeroplane & Motor Corp. at Buffalo will be ready for business by October 15. Despite the fact that the land for the new plant was only secured a month ago, all of the foundations have been laid and two of the bays have been completed. Four miles of track, giving the company the very best of railroad connections, have been laid.

The new plant will occupy nearly 160 acres of land, and should increase the present capacity over 600 per cent.

Ford Is Making Cylinders

Henry Ford has announced that the Ford Motor Company is making 200,000 steel airplane cylinders for the Government, which are to be delivered at the rate of 1,000 per day.

"We have just developed a way of making these cylinders from solid steel, and they can be manufactured very cheaply," said Mr. Ford. "If called upon to do so, this output can be increased to 5,000, or even 10,000, a day. It costs very little more to produce steel now than it did before the war."

The matter of price has been left to the Government after the cylinders are completed.

To Start Work on Airplane Factory

The construction of the new $1,000,000 airplane factory at the League Island Navy Yard will be started at an early date.

Secretary of the Navy Daniels has awarded to the Austin Company, of Philadelphia, the contract for the erection of the building.

"Philadelphia will become the great building center for the Navy," Mr. Daniels stated. "Fully $15,000,000 has been or will be expended there in the next few months. There should be employment for 3,000 or 4,000 men."

The building will be of steel and brick construction, 400 ft. square, and will be finished within the next three months.

Lawson Aircraft Corp. Elects Officers

The Lawson Aircraft Corp., Green Bay, Wis., organized with a capital stock of $200,000 to manufacture airplanes, has elected the following officers: President, George W. Ellis; vice-president and general manager, Alfred W. Lawson; secretary, F. L. Smith; treasurer, George A. Richardson; counsel, Max H. Strehlow; directors, William Hoberg, F. E. Burrall and Messrs. Ellis, Lawson and Richardson.

Standard Aero Corp. Expands

The Standard Aero Corp., of Plainfield, N. J., announces the purchase of the I. G. Brill Car Works in Elizabeth, N. J., for the manufacture of airplanes. The property represents a cost of $750,000, and it is estimated that, including equipment, the total cost of the establishment, before beginning operations, will amount to $1,000,000.

The growth of the Standard Aero Corp. has been one of the remarkable features of the American aircraft industry. The important factor in the building up of this firm has been its personnel, which includes some of the best brains of the aircraft industry.

Charles H. Day, the chief engineer and designer, is one of the pioneers of American aviation. He built the first tractor biplane in this country and also the rotary engine which propelled it. After having successfully flown this machine, he became associated with the Glenn L. Martin Co., of Los Angeles, Cal., in the capacity of chief engineer. After having severed his connection, he built a number of his own machines, but returned to the Glenn L. Martin Co. in 1914, where he remained until 1914, when he joined the Sloane Manufacturing Co., which eventually became the Standard Aero Corp. In his latter connection he built the well known H-3, J J-H, and speed scout type standard airplanes.

Harry Bowers Mingle, president, is in charge of the operations of the corporation and is its sole stockholder. To him is largely due the growth of this organization.

Loening Aeronautical Engineering Corp.

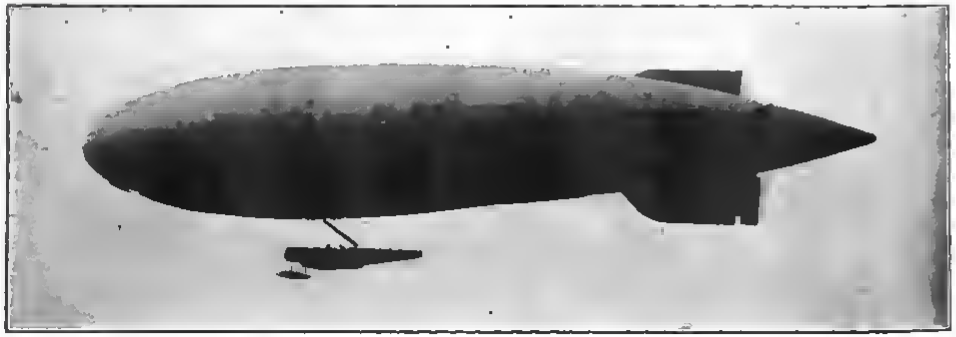
The Loening Aeronautical Engineering Corp., New York, has been incorporated with a capital of $25,000, to manufacture aircraft. G. C. and R. R. Loening and T. C. Curtis, 44 Wall Street, are the incorporators.

Boeing Airplane Co. Plans Extensions

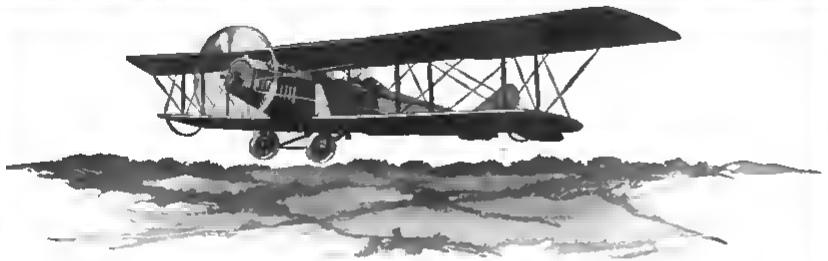
The W. E. Boeing Airplane Co., Hoge Building, Seattle, Wash., contemplates extensions and improvements to its factory on Lake Union.

Hydroreroplane Co. Organized

The Hydroreroplane Co. has been incorporated in New York with a capital of $30,000 by L. W. E. Coleman, C. L. Andrews and H. P. Keane. A flying field has been leased at Central Park, Hempstead Turnpike, L. I., and the company will give instruction in flying, photography, etc., to men above the age limit of the army, with a view of getting them to become observers.



An American "Blimp"



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Doebler Babbitt-Lined Bronze Bearings have been used with tbe utmost success by the largeat and most prominent motor builders in the Airplane as well as the Automobile industries.

The exercise of tbat same care in the selection of raw materials and in every stage of tbeir manufacture tbat has made us the leading and largest die-casting concern in tbe world, will insure tbe absolute dependability of that most vital part of your airplane motor — its bearings, if Doehler equipped, and safeguard its essential requisites.

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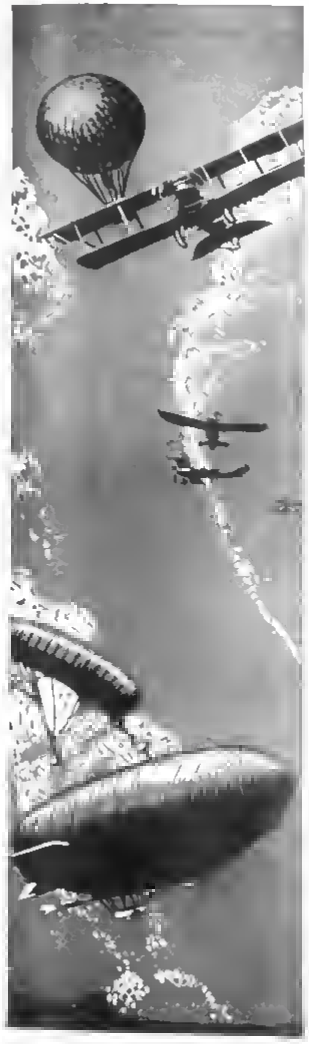
BOSTON — 723 OLIVER BUILDING



Fish of the Air

DIRIGIBLES have made significant progress from their earlier ungainly and baglike forms.

In the latest and highest development in this country, exemplified by the new Goodyear dirigibles now sailing the aerial seas, they resemble colossal sharks.

Their long stream-line bodies have horizontal and vertical rudders very much like fins.

Even the color has been changed to a sea-gray of low visibility.

The change is significant.

It not only serves to emphasize the later theory of dirigible design by accentuating the fishlike appearance and lines, but indicates another step forward in fabric development.

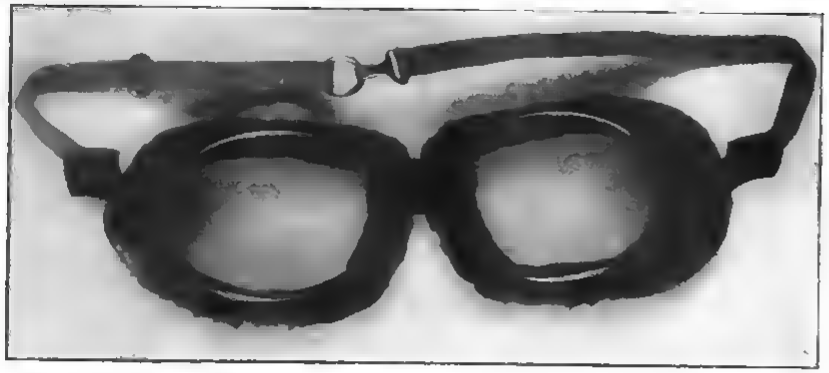
Once it was thought necessary to employ yellow fabric to assure adequate resistance to the effect of actinic light rays on the rubber impregnation and coating of the fabric.

Now yellow has been discarded and gray substituted in the Goodyear dirigibles, because the Goodyear processes of fabric manufacture assure adequate life without the employment of dangerously visible colors.

Everything in Rubber for Airplanes
Balloons of Any Size and Every Type

The Goodyear Tire & Rubber Company, Akron, Ohio

GOODYEAR
AKRON



RESISTAL
AVIATOR'S GOGGLES

Unbreakable

Resistal goggles are equipped with unbreakable lenses. **No glass will fly from *Resistal* lenses from a blow sufficient to shatter an ordinary lens.**

These lenses are made of a layer of transparent celluloid welded under enormous pressure between two layers of the finest glass, giving 97 64% of transparency and at the same time subduing some of the glare.

Bent for Side Vision

Resistal lenses are bent for side vision, increasing the range of sight of the wearer.

As the layer of celluloid acts also as an insulator, vapor **will *not* gather** on ***Resistal*** lenses.

Water-proof No adhesive cement is used in their construction, with the result that water has absolutely **no effect on *Resistal*** lenses.

Tested ***Resistal*** lenses have been subjected to the most rigid tests, and comply fully with the regulations of the Army and Navy.

Prompt Delivery can be had in any quantity. Write us direct for full information and prices.

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A TWO-PLY BIASED FABRIC, COATED BETWEEN PLIES WITH A LIGHT, TOUGH LAYER OF PURE PARA RUBBER.

THIS FABRIC HAS BEEN DEVELOPED FROM YEARS OF LABORATORY EXPERIENCE, AND POSSESSES EVERY FEATURE AND QUALIFICATION NECESSARY TO A WELL-BALANCED PRODUCT, VIZ .

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GAS-TIGHT
NEUTRAL, INVISIBLE COLOR
WITHSTANDS ALL WEATHER CONDITIONS
AND AGES WELL

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MADE BY THE
WORLD'S LARGEST RUBBER COMPANY

UNITED STATES RUBBER COMPANY
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IN ACTUAL DAILY PERFORMANCE

In every branch of military service—Engineering Corps, Aviation Section, Quartermaster Corps, and general Patrol, Scout, and Dispatch duty—you will find the 1917

Indian Motocycle
With Powerplus Motor

Greatest strength, endurance, speed, power, accessibility, and all-round dependability

We will be pleased to arrange demonstrations of all 1917 Indian models for interested military officials.

Illustrated 1917 Indian Catalog and other descriptive literature sent anywhere on request

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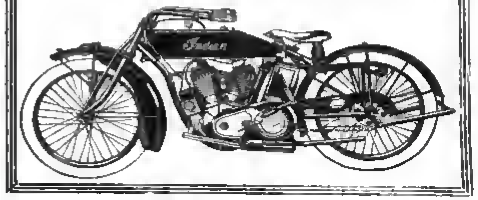

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Give the aviator a motor in which he can place thorough confidence—that's the first requisite of successful flying. Wisconsin Aeroplane Motors are that kind—noted for consistent performance—absolutely dependable. The product of the same engineering skill that has made Wisconsin Racing Motors champions of the world on road and speedway

Made in 8 and 12 cylinder sizes. Write for catalog with complete specifications.

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Equipment for

AEROSTATION FIELDS

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Reprint From

U. S. Government Advertiser

of August 23, 1917

Manufacturers' Representative

At a recent meeting of the American and Foreign Sales Corp., the following officers were elected: John L. Newbold, president, (president Merchants Transfer & Storage Co.), Ross P. Andrews, vice-president, (President R. P. Andrews Paper Co.), E. E. Thompson, secretary and treasurer (head of firm of Crane, Parris & Co.), Louis C. Witkowski, sales manager. The purpose of the corporation is to render an efficient service to both the selected large manufacturers who want personal representation before the Government and to the various branches of the U. S. Government. The corporation has been particularly fortunate in securing the services of Mr. Witkowski, who has represented one of the largest manufacturing concerns of the United States for more than 20 years.

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Tensile strength	44,250 lbs.	Sq. In.
Compression	126,000 "	" "
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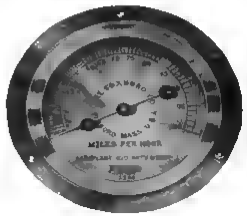

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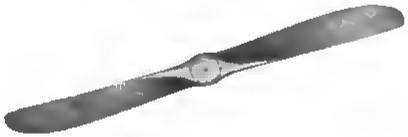

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Aeronautical Trade Directory

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Zenith Carburetor Co.

CLOCKS AND WATCHES
Ingersoll Robt. H. and Bro.
Chelsea Clock Co.
Cepoliler J. & Son
Waltham Watch Co.

CLOTHING
Abercrombie & Fitch
Rogers, Peet & Co
Sanders Co
Spalding A. G. & Bros.

COMPASSES
Sperry Gyroscope Co.
Taylor Instrument Companies

DOPE AND VARNISH
Adams & Elting Co
American Emaillite Co.
Chemical Products Co.
Conover, The C. E. Co
DuPont Chemical Works
Flexible Compound Co.
National Aeroplane Co
Pratt & Lambert
Standard Varnish Works
Valentine & Co.
Weeks & Co

DRIFT INDICATOR
Sperry Gyroscope Co.

DRY KILNS
Cutler Dry Kiln Co.
Grand Rapids Veneer Works

DYNAMOMETER
Sprague Electric Works

ENGINE PARTS
Akimoff, N. W.
Allegheny Forging Co
Hurd High Compression Ring Co
Dallet Thos. H Co.
Doehler Die Casting Co.
Erie Specialty Co.
Fibre Finishing Co
Gifford, Leland Co
Gill P H & Sons
Hydraulic Pressed Steel Co.
Lovell Walker M Co.
Park Drop Forge Co.
Standard Parts Co.
Taft Pierce Mfg Co
Tioga Steel & Iron Co
Williams J H & Co
Whitman & Barnes Mfg Co.
Wyman-Gordon Co.

ENGINEERING
Automotive Engineering Co.
Ordnance Engineering Co.

FABRICS
Courtland Mfg Co
Burnhead Mfg Co
Lamb Finley & Co
McBratney, Robt & Co.
Scott, Hotchkiss Co.
Whitman, Clarence & Co.

FIRE EXTINGUISHERS
Fyr-Fyter Co., The
Johns Manville Co., H. W.
Pyrene Mfg. Co.

GAGES
Crosby Steam Gage & Valve Co.
Foxboro Co., The, Inc.
United States Gage Co.

GASKETS
Fibre Finishing Co.

GLUE
Ferdinand, L. W., & Co.
Rheeler & Adamson

GOGGLES
Strauss & Buegeleisen

HANGARS
American Bridge Co
Anchor Corrugating Constr Co.
Ashley Steel Bldg Co.
Bowell, Field & Goddard Inc.
Kenaby & Mallison
Millikin Bros.
Preden, C D Co
Virginia Bridge & Iron Co.

LIFE PRESERVERS
Universal Safety Mattress Co.

LUMBER
Alcock Co. John L.
American Balsa Corp.
Chatham Lumber Co.
Colatour J
Dutton, A C Lbr Corp
Ludlow, Israel
Mengel C. C. & Bros. Co.

LUMINOUS COMPOUND
Cold Light Mfg Co.
Radium Dial Co
Radium Luminous Material Corp

MACHINERY, METAL WORKING
Dallen Mfg Corp
Warner & Swasey Co

MACHINERY, WOOD WORKING
Defiance Machine Works
Olney & Warrin

MANIFOLDS
Ajax Auto & Aero Sheet Metal Co.

MAGNETOS
Bosch Magneto Co.
Berkshire Magneto Corp.
Ericsson Mfg Co.
Remy Electric Co
Splitdorf Electrical Co

METALS
Acieral Co. of America
American Vanadium Co.
Bethlehem Steel Co.
Detroit Pressed Steel Co.
Federal Pressed Steel Co
Garland Ventilator Co.
Guder Paeschke & Frey Co.
Lovell, Walker M Co.
So-Luminum Mfg Co

MODEL AIRPLANES
Ideal Aeroplane Supply Co
Wading River Mfg. Co.

MOTORCYCLES
Excelsior Motor Mfg Supply Co.
Harley Davidson Co.
Hendee Mfg Co.
Sanderson Motorcycle Co

OILS AND LUBRICANTS
Baker Castor Oil Co
Graphite Lubricant Co.
Gell Refining Co.
Sheppard Ideal Oil Co.
Steuderd Oil Co
Swan & Finch
Texas Co
Vacuum Oil Co

OIL PUMPS
Wayne Oil Tank & Pump Co.

ORDNANCE
Driggs Seabury Ordnance Corp
General Ordnance Co.
Maxim Silencer Co.
Savage Arms Co.

PACKING
Fibre Finishing Co

PHOTOGRAPHY
Broch Arthur Jr
Herbert & Huesgen Co.

PISTONS
Lovell Walker M., Co.

PONTOONS
Niagara Boat Co.
Palmer-Simpson Corp
Welin Marine Equipment Co.

PROPELLERS
American Propeller & Mfg. Co.
Aviation Mfg Co
Buffalo Aeroplane Corp.
C M O Physical Laboratory
Doyle W A
Excelsior Propeller Co
Herriman Aircraft Motors Co
Lang Propeller Co
Schweizer & West Mfg Co.

PYROMETERS
Foxboro Co., The, Inc.
Shore Instrument & Mfg Co.
Taylor Instrument Companies

RADIATORS
Auto Radiator Mfg. Corp
Ajax Auto & Aero Sheet Metal Co.
A Z Co.
Bush Mfg Co.
El Arco Radiators Co
English & Mersick Co.
Livingston Radiator Co.
Rome-Turney Radiator Co.

RIVETS
Stimpson Edwin B. Co

SCLEROSCOPE
Shore Instrument & Mfg Co.

SHOCK ABSORBERS
Dural Rubber Corporation
Wood, J W Elastic Web Co.

SPARK PLUGS
Champion Ignition Co.
Johns Manville Co., H. W
Pyre Ignition Co.
Rajah Auto Supply Co.
Splitdorf Electrical Co

SPEED INDICATORS
Foxboro Co. The, Inc
Johns Manville Co., H. W
Stewart Warner Speedometer Corp

STABILIZERS
Greene Aeronautical Co.
Martin Aerodynamic Stabilizer
Sperry Gyroscope Co.

STARTERS
Bijur Motor Lighting Co
Christensen, The, Engineering Co
Dayton Engineering Laboratories Co
Motor Compressor Co.
Northeast Electric Co
Wagner Vinyl Electric Co.

TACHOMETERS
Johns Manville Co., H. W
Nelson Blower & Furnace Co.
Queen Grey Co
Stewart Warner Speedometer Corp
Veeder Mfg Co.

TANKS
Janney Steinmetz & Co.

TELEPHONES
General Acoustic Co. (Aviophone)
Kressler Electric Co.
Telautograph Corp
Western Electric Co

THERMOMETERS
Foxboro Co., The, Inc
Taylor Instrument Companies

TIRES AND RUBBER
Dural Rubber Corporation
Goodyear Tire & Rubber Co.
Hodgman Rubber Co
United States Rubber Co

TOOLS
Browne & Sharpe
Hall-Scott Motor Car Co

TRUCKS AND TRAILERS
Federal Motor Truck Co
Four Wheel Drive Auto Co.
Nash Motors Co
Packard Motor Car Co.
Sechler & Co The
Service Motor Truck Co
White Co

TUBING
Empire Art Metal Co
Fresse Pater A B Co
Pennsylvania Flexible Metallic Tubing Co

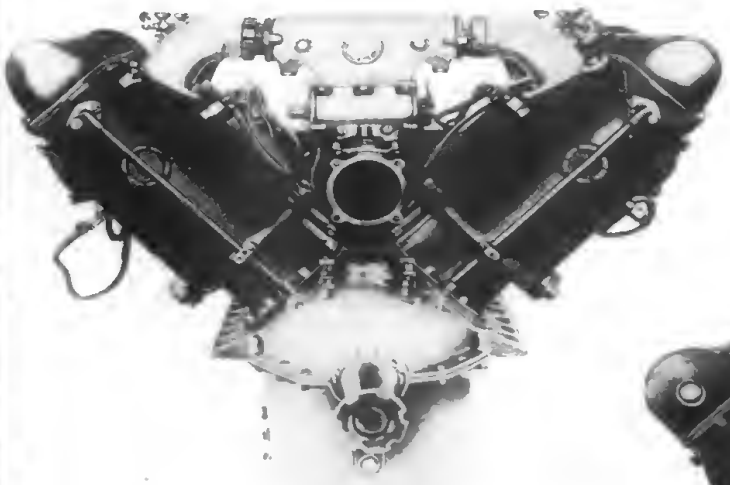
TURNBUCKLES
Aero Mfg & Accessories Co
Ajax Iron Works
C & Aeroplane Works
Dillner Meyer Mfg Co
Erie Specialty Co.
National Aeroplane Co
New York & Hagerstown Metal Stamping Co
Standard Screw Co

WHEELS
Ackerman Wheel Co
Mott Wheel Works
National Wire Wheel Works
Wire Wheel Corporation of America

WIRE
American Steel and Wire Co
Century Telephone Construction Co.
Electric Cable Co
Roebling's John A. Sons
Simplex Wire and Cable Co.

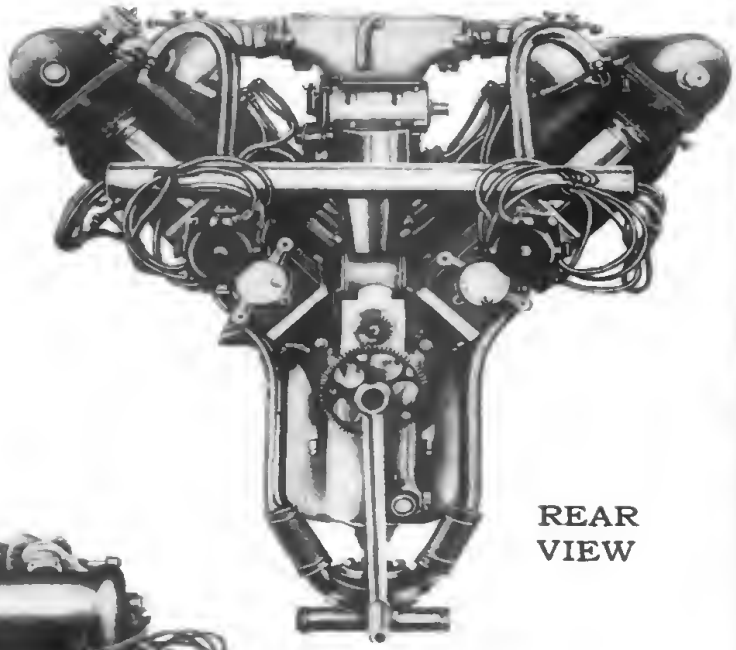
WIRELESS
American Radio & Research Corp
American Wireless Tel. Co.
Cutting & Washington.

HISPANO-SUIZA

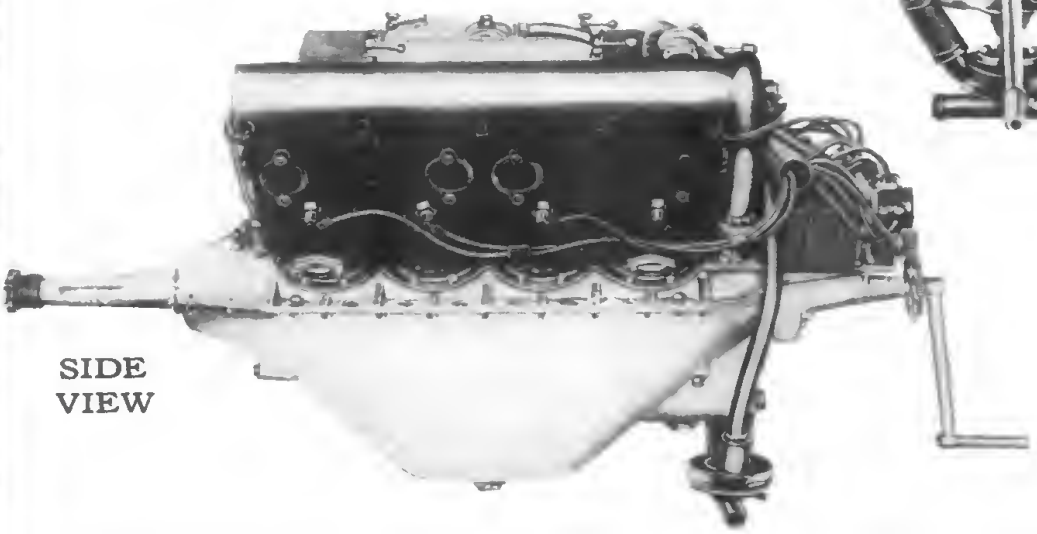


FRONT VIEW

DEVELOPS 150 H. P. AT 1450 R. P. M.



REAR VIEW



SIDE VIEW

WRIGHT-MARTIN AIRCRAFT CORPORATION

New Brunswick, New Jersey